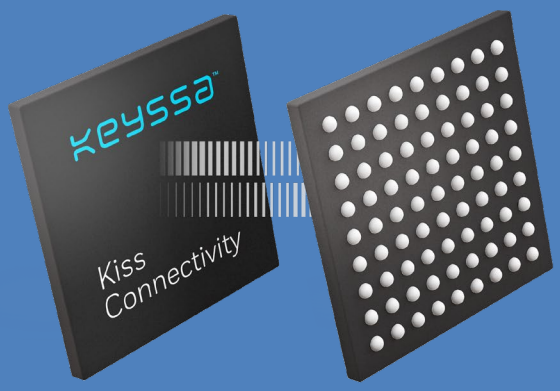
keyssa

RELIABILITY AND SECURITY OF KEYSSA'S SOLID-STATE CONNECTORS

Wireless Convenience with Solid-state Reliability and Physical Security



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Introduction to Keyssa's solid-state connector

This paper provides a brief overview of Keyssa's solid-state connector technology (Kiss Connectivity) and focuses on two key attributes: reliability and security. Current cable/connector technology used in video walls, specifically the RJ45 connector, are prone to reliability issues.

1. Reliability: Because Keyssa's product is solid-state and embedded inside the skin of a product, Kiss Connectors are not prone to wear and tear, water, or other environmental hazards that can affect the performance of a traditional connector.
    a. This paper describes the reliability of Keyssa's technology and compares that reliability to the commonly used RJ45 connector
2. Security: Because Keyssa is a near-field, point-to-point connection, security of the Keyssa link is comparable to the security of wired connections.

Keyssa contactless connectivity versus traditional wireless

Why Kiss Connectivity performs more like a wire than wireless

Although Keyssa technology transmits data wirelessly, the technology underlying Keyssa's solid-sate connector is fundamentally different from what we typically think of as wireless. Whereas 802.11-based wireless technologies focus on connecting multiple devices at distance, Keyssa's technology is designed to emulate the behavior and characteristics of a mechanical connector – but without the mechanical portion (plug and receptacle, or two metal pins/pads coming into contact, etc.).

Similar to a mechanical connector, Keyssa's Kiss Connectors "connect" when two devices come into close proximity (approximately 1cm). Because Keyssa technology operates at such close proximity, and because the technology is not trying to connect multiple devices (similar to Wi-Fi), the technical characteristics of the connection are closer to a wire than to traditional wireless technologies. Throughput is higher, power is lower, latency is lower, reliability of the link is much higher, and security of the link is much greater.

Keyssa Versus Traditional Wi-Fi
Technical performance closer to a wire than wireless

	Traditional Wireless (Wi-Fi)	Keyssa
Range	Meters	Approximately 1cm (touch)
Throughput	Order of 30Mbps	Up to 6Gbps per lane
Power	Watts	<100mw
Bit Error Rate (BER)	Varies between 10^{-3} and 10^{-7}	10^{-15}
Connection	Shared (Mesh Network)	Dedicated (point-to-point)
Latency	Milliseconds	500 picoseconds
Software/firmware required	Drivers	None – OS transparent
Security	Prone to snooping	Unable to snoop

Reliability of Keyssa's solid-state connector

Mean Time Between Failure (MTBF)

Because Keyssa's Kiss Connector is solid-sate technology, it has the reliability of a semiconductor device. With no mechanical moving parts and embedded just beneath the skin of a device, Kiss Connectors have a Mean Time Between Failure (MTBF) rate in the thousands of years.

Keyssa's solid-state reliability
MTBF in the '000s of years

System (Use) Ambient Temp	FITs	MTBF Hours	MTBF Years
25.0 °C	1.17	851,681,270	97,224
35.0 °C	2.56	391,080,106	44,644
45.0 °C	**5.32**	**188,039,349**	**21,466**
55.0 °C	10.60	94,298,116	10,765
65.0 °C	20.35	49,147,100	5,610
70.0 °C	27.81	35,961,752	4,105

Fit = Failure Units (1/billion device hours)

Bit Error Rate (BER)

Traditional 802.11 (Wi-Fi) technology has a BER of between 10^{-3} – 10^{-7}. Because Keyssa's technology is near-field and a point-to-point connection, the RF antenna is highly directional. This highly focused, near-field connection translates to a very low BER of 10^{-15} (equivalent to the BER of a wire).

BER equivalent to a wire: 10^{-15}

TJ	52.01 ps
DJ	22.66 ps
RJ	2.09 ps
Rise Time	88.79 ps
Fall Time	89.96 ps

Reliability comparison between Keyssa and RJ45

Standardized in 1976, the RJ45 connector was originally developed as part of the telecommunication network interface for the purpose of connecting telephone networks. As a 40^{+}-year old design, the RJ45 connector is challenged to meet the emerging technical requirements of many applications, including video wall connectivity. Several key design issues are evident when using the RJ45 as an interconnect for video walls:

1. Contact point stability; The dimensions and tolerances enforced by the IEC60603 series allow for very large movements of the contact point (worst case up to 1.08 mm in mating direction) and contact normal force variations.
2. Single contact point; contact systems with only a single beam / contact point can be very stable, but in combination with poor contact point stability induced wear, not having redundancy from parallel contact points shows resistance fluctuations directly. Especially when mating cycle wear is followed by environmental stressing.
3. Shear edge connection: The stamping direction of the piercing contact will create a sheared edge on the contact mating surface. Some RJ45 plug contact surfaces are smoothened.
4. Wire termination pierce contact principle: during piercing the tool presses on the contact surface, inducing the risk of deforming or damaging the surface. RJ45 receptables are right angle SMD type jacks, except for one through hole reflow type.

Reliability of the RJ45 connector over time

The following data was posted on behalf of TE connectivity by EURO Circuits[1].
Reliability testing was done on 5 different manufacturers of RJ45 connectors:

- Common industrial grade Cat 5e cables, having 26AWG (0.13 mm2) wires
- RJ45 receptables are right angle SMD type jacks, except for one through hole reflow type.
- RJ45 plugs are pierce or field installable types
- All connector brands are tested in pairs; plug and jack are of the same brand with the exception of one pair

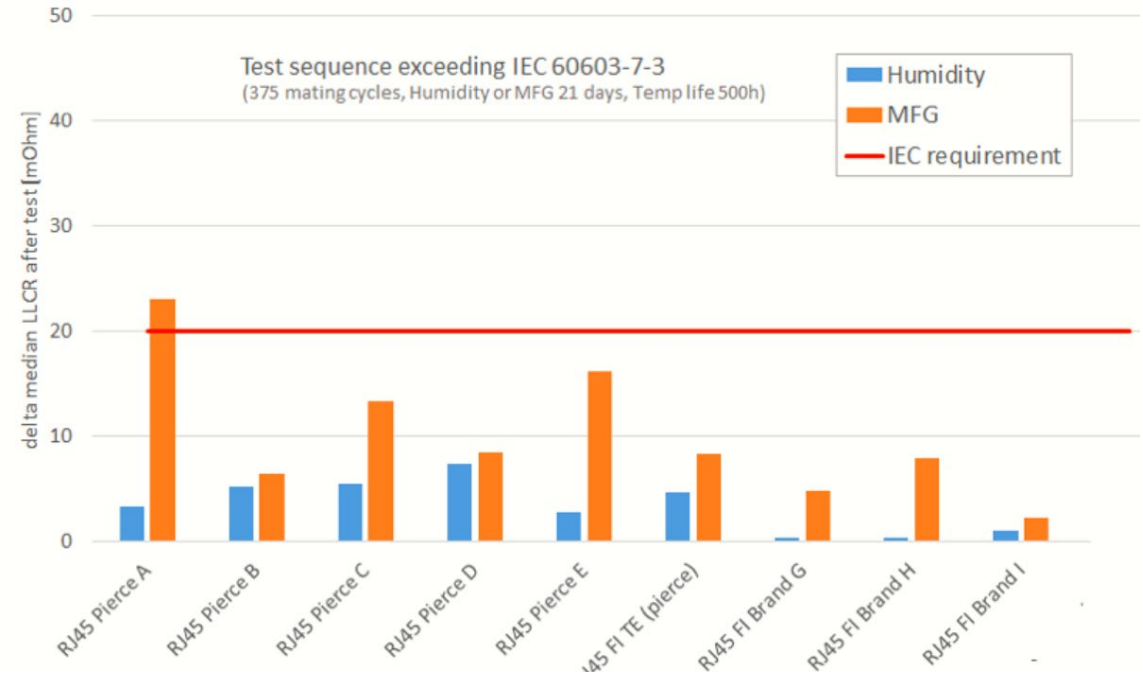
Reliability testing: impact of humidity, vibration, insertion, EMI, dielectric withstanding voltage

Connectors were tested for performance and reliability based on:

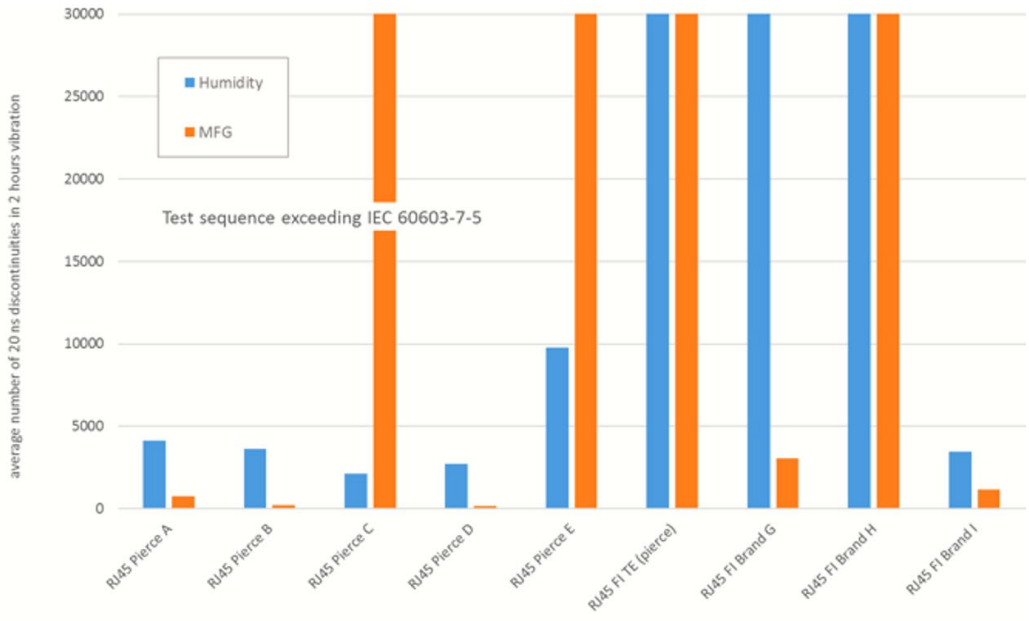
1. Low Level Contact Resistance (LLCR) after 375 mating cycles
2. Discontinuities after mating cycles/environmental stressing and vibration
3. Dielectric Withstanding Voltage – test until failure
4. LLCR during cable movement

Key results of the testing are shown below:

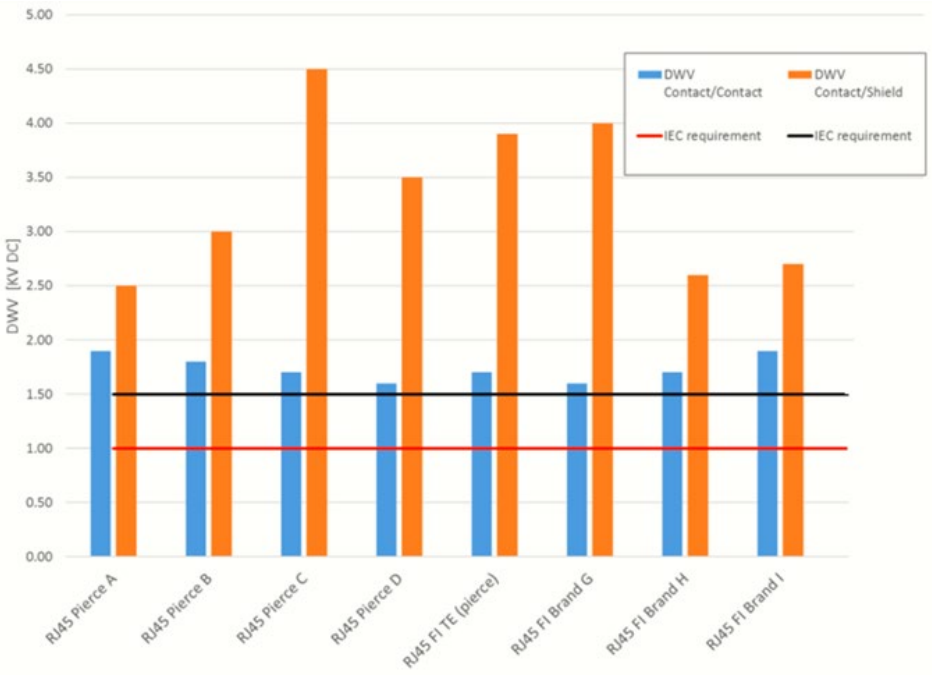
Increase in signal contact LLCR after mating cycles,
environmental stressing and vibration



Discontinuities after mating cycles / environmental stressing during vibration, 8 signal contacts in series



Dielectric Withstanding Voltage – test until failure



Low Level contact Resistance [mΩ] over time [s]
during cable movements after 375 mating cycles,
Mixed Flowing Gas 21 days, Temp life 500h, Vibration 20g

Summary of RJ45 connector reliability:

As a mechanical construct, the RJ45 is prone to reliability associated with multiple factors including, multiple insertions, humidity, ESD and low-level contact resistance.

Pogo pins for data transmission

One of the older, widely used contacts, the pogo pin, has long established itself as a reliable and trustworthy technology for many applications. Named after the pogo stick toy over forty years ago, this golden spring-loaded contact has played a vital role in making temporary connections, usually for electronic testing, since it was first created.

Examples of Pogo Pins

Pogo Pins are always a consideration for data transmission and can be a reliable connection for power and low speed data signals. However, this 40-year old technology is not designed to reliably transmit speeds above USB2 speeds of 480Mbps. Additionally, the pogo pin design requires tight alignment between the pin and the pad, where the connection is made. This is especially true when trying to transmit 1Gbps^{+} data rates over a pogo pin connection.

When it comes to high-speeds circuits, pogo pins will fail. Efforts have been made to design pins that can transmit data rates above 1Gbps, but the fundamental design of the pogo pins fails at speeds > 2-3 Gbps. As well, even if these speeds were possible, the cost and alignment requirements of these higher speed pogo pins becomes prohibitive.

Pogo Pin Alignment is Critical

Pogo pins rely on near-perfect contact between the springs and pin to perform optimally. Mechanical alignment tolerances of ± 0.3mm are required, compared to ±1.5mm for Keyssa's solid-state connector. The pogo pin also requires a strong magnetic force to maintain a robust connection.

And of course, since pogo pins are exposed to the environment, they are susceptible to water, moisture, dust, contamination and rust.

Security of the Keyssa link

Unlike traditional Wi-Fi technology, which broadcasts a wireless signal so that products within range can connect by logging on, Keyssa is a near-field point-to point connection. As such, it becomes nearly impossible to "sniff" the Keyssa signal:

- As a point-to-point near-field wireless interconnect, the signal is highly directional and not broadcasted in every direction.
- Because the signal only needs to travel a short distance (approximately 1 cm), beyond this distance, the signal dissipates quickly. With very low power, a Keyssa devices is extremely difficult to detect outside the connection area of 1cm, even with the most sophisticated snooping devices.
- Keyssa operates in the 60GHz portion of the spectrum, which means even if someone were to attempt to detect the signal, it would require specialized equipment that is not available on the market.
- Keyssa's solid-state connector is a proprietary connector and would require companion Keyssa chips in order to receive a signal.
- Multi-channel Extremely High Frequency (EHF) channels, such as those required to connect video wall cabinet via an Ethernet connection with Keyssa, create multiple streams of 60GHz signals. This means that there are two contiguous signals operating at close proximity. This increases the difficulty of an undesired device connecting with a Keyssa signal.

- Keyssa's Kiss Connectors must be aligned, face-to-face in order to pass data. Simply trying to read the data that is passed between two Keyssa devices by trying to detect the wireless signal is extremely difficult.

Even Keyssa, who has developed this technology, has not successfully been able to "sniff" a Keyssa link using any combination of devices and equipment.

Summary

Reliability and performance of Keyssa's Solid-State Connector

Traditional mechanical interconnects, including the RJ45 and pogo pins, were never designed to meet the needs of video wall designs and installations.

- Reliability issues occur with multiple insertions/connections, vibration, humidity, and other environmental factors - all of which pertain to video wall installations
- Shielding can crack over time, radiating energy and creating EMI/RFI
- Higher data rates increase the likelihood of reliability issues

Keyssa's solid-state connector is designed to provide a highly reliable, near-field connection between two devices using a wireless link at the last centimeter. As such, the Kiss Connector:

- Is immune from environmental hazards such as water, dust, lint, and other debris that can cause failure of a mechanical connector.
- Has no wear and tear from multiple insertions
- Has solid-state reliability, which means MTBF in thousands of years
- Has performance characteristics closer to a wire than to traditional wireless technology:
    - BER of 10^{-15}
    - Latency of 500 picoseconds
    - Low power
    - No drivers or software required; like a connector, Keyssa is a hardware solution

Security of Keyssa's Solid-State Connector

Although wireless at the last centimeter, Keyssa's solid-state connector is as secure as a traditional mechanical connector.

- Ultra-low power, near-field signal not possible to sniff
- Keyssa's connector is embedded under the skin of a device; unlike mechanical connectors, Kiss Connectors are not visible without breaking open a product.

- If disconnected from its companion device, Kiss Connectors cease to output a signal.

References and more information

[1]Industrial Ethernet Connector Benchmark

- https://www.eurocircuits.com/blog/white-paper-reliability-comparison-of-rj45-and-mini-io/

Pogo Pins: A 40-Year-Old Technology

- http://www.keyssa.com/pogo-pins-a-40-year-old-technology/

For More Information on Keyssa Products:

- Keyssa Web Page:
  - www.keyssa.com
- Keyssa Video Wall web page with video demonstrations and product brief downloads:
  - http://www.keyssa.com/videowall/
- Recent News About Keyssa
  - Electronic Design: Can You Take the Connector Out of the Connector
  - https://www.electronicdesign.com/analog/can-you-take-connector-out-connectors
  - Keyssa and Novastar Announce Strategic Partnership
  - http://www.keyssa.com/novastar-keyssa/