



DeoxIT® Test Report – Data
Product Testing: “Rejuvenation”

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Testing Focus: Contact & Connector “Rejuvenation” and/or “Improve” Contacts & Connectors

Introduction:

The tests CAIG Labs conducted will demonstrate DeoxIT® D5S-6 (DeoxIT® D-Series products) not only removes surface contamination with a hydrocarbon solvent, it will also lift off and displace oxidation which increase resistance and degrade electrical/electronic connections without harm to metal and plastics.

DeoxIT® rejuvenates and improves contacts & connections and provides long-lasting protection;

- Increasing life of equipment,
- Saving companies money,
- Saving manufactures significant warranty costs,
- Increasing performance and reliability.

There are many contact and connector cleaners available today from many companies. Most cleaners are just a variety of different solvents or solvents with an added lubricant; for example, silicone, mineral oil or other lubricating hydrocarbon. These products may do a fairly good job cleaning/flushing away surface contamination, however, they don’t get to the root of the problem, rejuvenate or improve the electrical contact surfaces.

Testing focus: “Rejuvenate” and “Improve”

Contact & Connector Materials:

For the most part, almost all contacts and connectors are composed of a base metal which is then plated with a variety of metals; usually tin, nickel, silver or gold. The use of the plated metals is to help prevent oxidation, wear and deterioration of the contact surfaces. The common base metal in most contacts and connectors is copper.

Sensitive Plastics, Materials and Electronics:

Just as important as improving and protecting the connections, is compatibility with all the materials associated with electronic components and equipment. Many contact cleaners, lubricants and solvents currently on the market can cause degradation of materials, causing additional and more serious problems. The degradation can happen quickly, or it may take months or years to affect the plastics and component materials. CAIG has worked extensively with leading manufacturers over the 60+ years, to ensure compatibility of DeoxIT® with materials and electronic components.

Why Contacts & Connectors Fail:

Many factors cause connectors to fail such as design issues, manufacturing process, cleaning process, wear/damage and environmental factors. DeoxIT® will significantly improve performance and reliability unless parts are physically damaged or from poor design issues.

Design: If the design of the contacts/connectors is not correct, this can cause adverse conditions; excessive wear and intermittent connections are usually the result.

Manufacturing: Contacts and connectors are made all over the world and the quality control at the plants vary greatly. CAIG has seen issues with the quality of the materials used (copper, nickel, gold, etc.) and the plating processes.

Cleaning: If during the manufacturing process, the parts/connectors are not cleaned properly, they can cause intermittents, errors and damage the mating surfaces. CAIG has seen flux, blood, skin, feces, and other contaminants on NEW parts.

Wear/damage: Over time, contacts and connectors will wear away the plated surfaces and expose the copper base metal, especially if the connectors are re-inserted many times or the design or plating is inferior. The copper is then exposed and subject to oxidation rapidly.

Environmental: Humidity and environmental contaminants (salts, sulfurs, acids, pollution, etc.) over time will oxidize and deteriorate metals, especially those that are easily subject to oxidation and corrosion (such as copper, nickel, silver and steel).

In short, due to these contaminants, oxidation on contacts and connectors continue to increase the resistance until intermittents occur and eventual failure. Examples of this would be decreased brightness in lights, noise and distortion on audio and video, data errors and slower data speeds on computers, decreased battery life and charging, etc.

Why DeoxIT® D5S-6:

DeoxIT® is unique in the following ways:

- a) Only product that truly Rejuvenates
- b) The DeoxIT® D5S-6, with a solvent, flushes off loose surface contaminants.
- c) Dissolves oxides and contamination
- d) Lifts off surfaces hard/attached contaminants; flux, particles, etc.
- e) Improves conductivity at monomolecular layer
- f) Lubricates surface to prevent damage
- g) Seals and re-seals surfaces
- h) Safe on plastics and sensitive electronics
- i) Provides long term protection

How DeoxIT® Rejuvenates and Improves:

Once metals start to oxidize (especially if the base metal, copper, is exposed), the resistance of the connection will start to increase from copper oxide formation. Over time this will decrease the efficiency of the connection, until it eventually fails. Increased resistance, for example, could cause intermittent connections, increase power consumption, data errors and result in complete failure.

DeoxIT®'s unique formulation will dissolve/deoxidize these contaminants (such as copper oxides). When you apply DeoxIT® to the connection, it will immediately start to deoxidize the contaminants. The resistance will start to decrease, re-connecting the native surfaces. Over time the DeoxIT® will continue to deoxidize, reduce resistance, and improve connection surface contact.

Testing Challenge:

The challenge in testing products for “rejuvenating” and “improving” electrical connections is creating “real-life” conditions and repeatability for one or more products. Creating test setups and procedures in the lab is time consuming and difficult to provide accurate results. Lab testing is usually done by placing contacts and/or connectors for a pre-determined amount of time in either a humidity chamber, salt spray/humidity chamber or a mix flow gas chamber. This procedure is done to try and expose parts to “real-life” environmental conditions.

Getting consistent and repeatable chamber samples was our most difficult challenge. Ultimately, for test 2c (Pressure/Resistance Test), we used material directly from the supplier without placing in a chamber.

CAIG’s experience over the past 60 plus years working with leading companies in industry (Bose, Honeywell, HPE, IBM, Intel, NASA, Tektronix, etc.) has determined that the best way to insure accurate results on critical applications is to do in house lab testing and real-life condition testing.

PRIMARY GOALS FOR TESTS:

1. **PRIMARY:** Determine primary “Claim” = DeoxIT® rejuvenates and improves electronic contacts and connectors
2. **LAB TESTS:** Establish several “Lab” tests that are repeatable.
3. **REAL-LIFE TESTS:** Try to determine a “Real-Life” test that is repeatable.

ADDITIONAL TESTS:

4. **DeoxIT® WOWS and YouTube Videos:**
5. **Plastics Compatibility:** Unexpected observation.

1. PRIMARY. It is determined that the uniqueness of DeoxIT® is its ability to **repair or rejuvenate** a failed or intermittent electronic connection. No other product makes this claim because DeoxIT® is the only one that can achieve that result.

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2. LAB TESTS: The following tests were determined to be the easiest and best way to prove this claim and would be easily repeatable to verify claims on packaging or advertising.

2a. PENNY TEST:

The below image shows the setup for showing deoxidation results on pennies with 5 products: 3M Novec Contact Cleaner and Lubricant, WD-40, DeoxIT® D5S-6, CorrosionX and NU-TROL Contact Cleaner and Lubricant.



TEST: Place dirty pennies (6 each) into jars. Spray each product into jars until all pennies are covered in product. Screw covers onto jars. Let sit for one week.

Why this test? Most contacts and connectors contain copper or tin as the base metal, such as those used in audio/video, computers, cell phones, lights/plugs/sockets, batteries, switches, etc. Since these dirty pennies represent a “real-life” test of oxidized copper, if we can clean/deoxidize these pennies with products, it will demonstrate we can repair/rejuvenate the connector to a working/clean state.

How will we determine/notice the change?

When copper or other yellow metals, such as brass and bronze is deoxidized, *copper oxides* form and will show a “green color”. The white metals silver, tin, nickel, etc. when deoxidized, will show as “black” and form silver oxides, nickel oxides, etc. We selected copper since most connectors have it as the base metal.

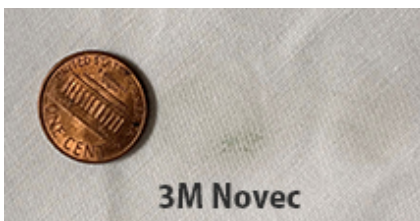
Why a one-week soak?

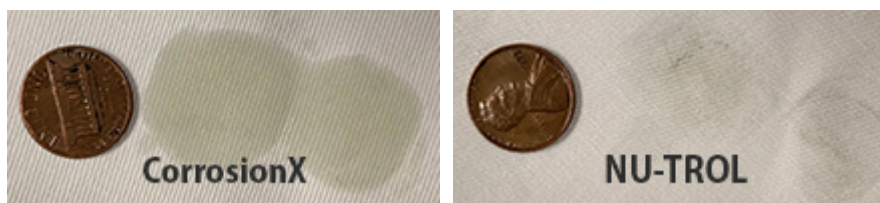
DeoxIT® will deoxidize the pennies (copper) very quickly and will continue deoxidizing over time. After a few hours you may notice copper oxides (green color) on the DeoxIT® treated penny. That’s why a DeoxIT® treated connector improves over time. The “green” color may not be noticeable immediately, so we leave it soaking for one week. It also demonstrates the other products are not successful in deoxidizing, rejuvenating and improving the connectors over a length of time.

After one week:

For each product other than DeoxIT®, take one penny out of the jar and wipe it on a clean white cloth. You will notice NO change in color from the original solution. Wipe the surface with the DeoxIT® treated penny and you will notice a “green” color. This indicates copper oxides are being lifted off the surface.

NOTE: When copper oxides are lifted off the surface by DeoxIT®, there is no damage to the metal surface. We do not want to change (remove metal) the design specifications of the contact/connector. If you do, you risk decreased reliability and performance. There are very aggressive metal cleaners that will actually remove metal from surfaces (Tarn-X, acid-based solutions, etc.) and are also very aggressive to other materials (plastics) in connectors.





Observations:

DeoxIT®: Deoxidized and lifted a significant amount of copper oxides (green) off the surface.

3M Novec: Cleaned a slight amount dirt/grease off the surface – NO oxide removal

WD-40: Cleaned a moderate amount of dirt/grease off the surface – NO oxide removal

CorrosionX: Did not appear to remove dirt/grease (original oil color on cloth) - NO oxide removal

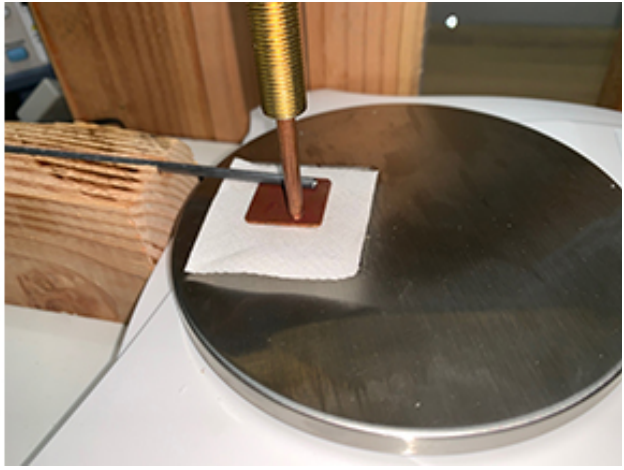
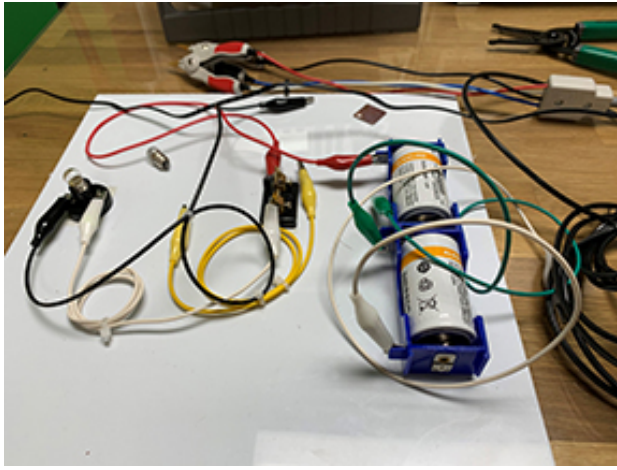
NU-TROL: Cleaned a slight amount of dirt/grease off the surface – NO oxide removal

CONCLUSION: (What does the green color mean?)

The green color indicates “copper oxides” have been lifted off the surface. On electronic connections, oxides impede electrical signals. As oxides build up over time, resistance increases, causing intermittents, data errors, degraded audio/video, decreasing performance and reliability until the connection finally fails. ONE of the attributes of DeoxIT®, is it is the only product that will lift these oxides off the surface (faster under voltage/current), decreasing resistance (and will continue over time), thereby restoring the integrity of (“Rejuvenating”) the connection. All this without damaging sensitive materials and electronic components.

SETUP for TEST 2b and 2c





2b. Resistance/Minimal Pressure Test:



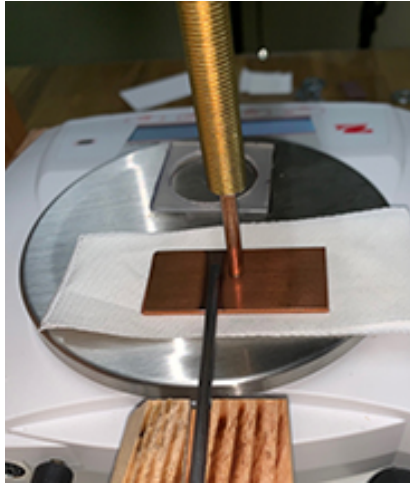
Link to Video: [\(Resistance Test - 2b\)](#)

Two tests performed; **(2b)** Direct test on one coupon and treat with each product, DeoxIT® D5 being the last to treat. Select link above to view test (both videos are the same, just different format). **(2c)** Measure resistance on individual test coupons, then treat with products. Measure change in resistance at a variety of time intervals.

2c. Oxidation/Resistance Test:

Similar to the test Delta/Airbus reliability engineer performed on connectors subject to severe corrosion.

Setup:



- 1" x 1/16" copper bar (Cu) and then nickel/copper alloy (Ni/Cu) was cut into 1 x 2" coupons.
- Coupons were left as is – not put into an environmental chamber. Slight oxidation noticed.
- Horizontal and vertical probes were put onto coupons, 1 cm apart
- Pressure from vertical probe onto coupon was set at 10 grams.
- Without treatment, resistance meter was allowed to stabilize for a few minutes.
- Measurement recorded.
- After 60 minutes, surface was wiped with lint-free cloth then measurement recorded.
- After 24 hours, surface was wiped with lint-free cloth then measurement recorded.
- After 48 hours, surface was wiped with lint-free cloth then measurement recorded.
- Note: After every 8 hours the table was vibrated for 1 min.
- Procedure was performed on each product.



Resistance Before



Apply Product



Product on surface

TESTS	Cu #1	Cu #2	Cu #3	Ni/Cu #1	Ni/Cu #2	Ni/Cu #3
A. 3M Novec:						
Resistance (ohms) before applied =	0.3864	0.4365	0.4139	0.4587	0.4211	0.4631
Resistance after 60 min =	0.6752	0.7214	0.7501	0.6128	0.5919	0.6212
Resistance after 2 hrs =	0.7443	0.7965	0.8045			
Resistance after 24 hrs =	0.4858 *	0.5124	0.6293	0.5228	0.5236	0.5441
Resistance after 48 hrs =	0.5668	0.5992	0.6419	0.5382	0.5301	0.5426

* Looks like over the 24 hour period the fluid thinned out (spread out); thereby reducing the insulation thickness. Fluid is still an insulator – resistance above the non-treated coupon.



NOTE:
No oxide removal.
Looks like lubricant
residue.
Lubricant is clearly
an insulator.

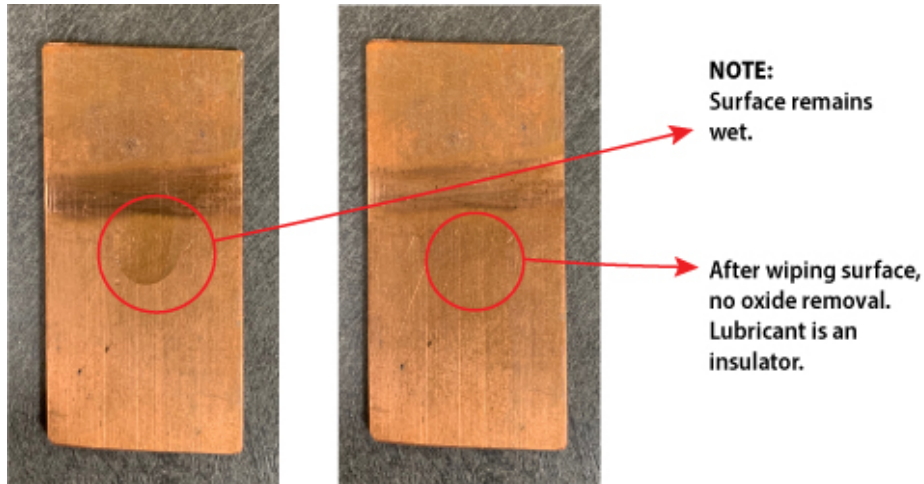
TESTS	Cu #1	Cu #2	Cu #3	Ni/Cu #1	Ni/Cu #2	Ni/Cu #3
B. WD-40:						
Resistance (ohms) before applied =	0.3182	0.3563	0.3338	0.3898	0.3822	0.4277
Resistance after 60 min =	0.5319	0.6139	0.6003	0.7820	0.7618	0.7831
Resistance after 24 hrs =	0.5548	0.6261	0.6098	0.6320	0.6198	0.6554
Resistance after 48 hrs =	0.3856	0.4025	0.3852	0.6450	0.6309	0.6491



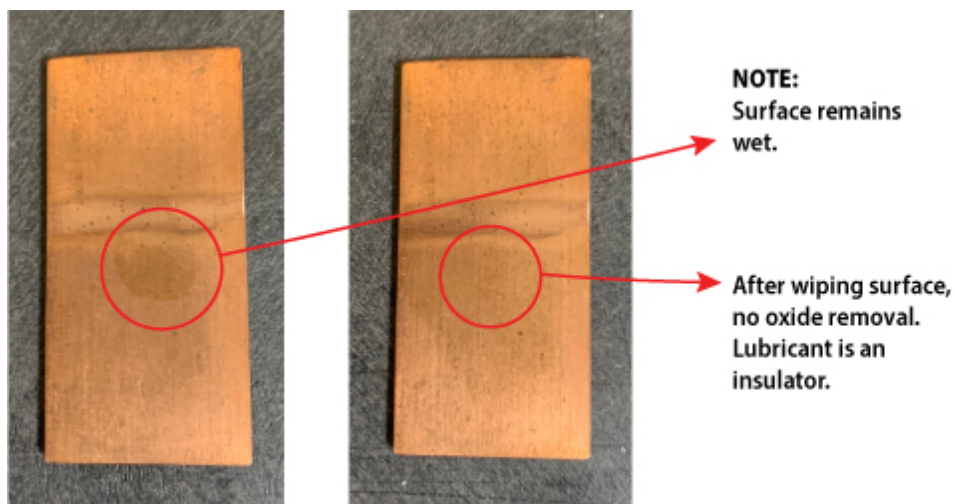
NOTE:
Surface remains
wet.

After wiping surface,
no oxide removal.
Lubricant is an
insulator.

TESTS	Cu #1	Cu #2	Cu #3	Ni/Cu #1	Ni/Cu #2	Ni/Cu #3
C . CorrosionX:						
Resistance (ohms) before applied =	0.3168	0.3967	0.4017	0.4492	0.4126	0.4544
Resistance after 60 min =	0.5905	0.6532	0.6598	0.6158	0.5917	0.6173
Resistance after 24 hrs =	0.3788	0.4738	0.5741	0.5926	0.6023	0.5986
Resistance after 48 hrs =	0.3856	0.4681	0.5148	0.5708	0.5938	0.6001

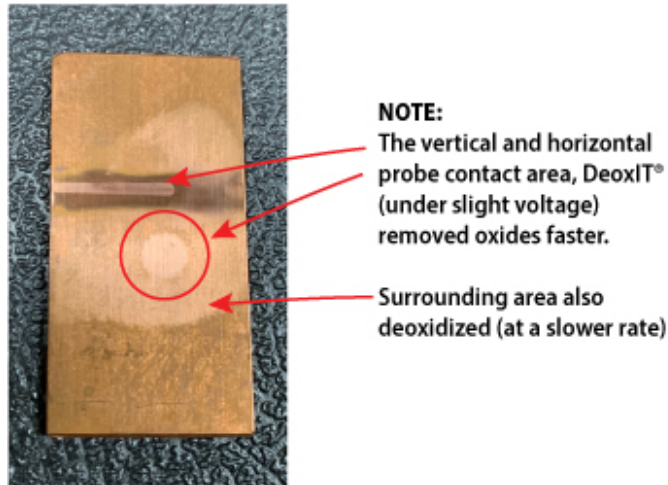


TESTS	Cu #1	Cu #2	Cu #3	Ni/Cu #1	Ni/Cu #2	Ni/Cu #3
D . NU-TROL:						
Resistance (ohms) before applied =	0.3174	0.3327	0.3748	0.4192	0.4226	0.3993
Resistance after 60 min =	0.3836	0.3572	0.4017	0.5612	0.5775	0.5449
Resistance after 24 hrs =	0.3768	0.3652	0.3983	0.5791	0.5982	0.5739
Resistance after 48 hrs =	0.6638	0.6381	0.5112	0.5963	0.5617	0.5626



TESTS	Cu #1	Cu #2	Cu #3	Ni/Cu #1	Ni/Cu #2	Ni/Cu #3
E . DeoxIT® D5:						
Resistance (ohms) before applied =	0.3663	0.3927	0.4154	1.2303 *	0.4318	0.4523
Resistance after 60 min =	0.2332	0.2459	0.2497	0.5374	0.3459	0.3541
Resistance after 24 hrs =	0.2120	0.2312	0.2238	0.4331	0.3166	0.3097
Resistance after 48 hrs =	0.1997	0.2034	0.2093	0.3994	0.3002	0.2991

* High start valve, want to re-check on 2nd and third test (perhaps more than 1 cm apart)



NOTICE ON TEST COUPON: DeoxIT® removed copper oxides at the contact points and surrounding area! Result, reduced resistance and better contact/connection. Notice the horizontal and vertical contact points - slight current and pressure makes the deoxidizing quicker.

3. REAL-LIFE TEST:

There are several aspects to real life tests. One is the environment the components are exposed to (heat/cold, humidity, salts, acids, sulfurs, chlorine, and other pollutants). The second is the electrical connection that the circuits are exposed to (currents, voltages, noise/distortion, arcing/spikes, RFI, etc.), which can accelerate oxidation, dendrites, blistering and other damaging effects.



(a)



(b)

Figure 1. Example of a potential-driven corrosion mechanism (dendrites) in power semiconductors that can only be reproduced with electrically live MFG testing: (a) field return, (b) MFG test.

(See Link to article on next page)

Link to article:

https://www.researchgate.net/publication/331099718_Challenges_and_Best_Practices_in_Mixed_Flow_Gas_Corrosion_Testing_of_Electronics

NOTE:

How Dendrites grow/form: a. Voltage (1-1.5 or greater voltage difference) b. Fluid Media (break in surface exposing to environment), c. Corrosive ions to dissolve.

A DeoxIT® treated surface prevents these dendrites from forming or stops it if started. DeoxIT® gets into gaps, dissolves metal oxides and seals out oxygen from getting to surface.

REAL-LIFE Testing is a more difficult undertaking. Coming up with a verifiable and repeatable real-life test can be done, however it would take many similar parts, a very long time, and requires locating similarly damaged/oxidized parts. **Suggestion:** Find a surplus of 1,000 potentiometers that have been exposed for a very long time, 5-10+ years. Then take the 5 products and test each of the products on 200 of the potentiometers. The results can be determined on percentage of improvement by each product. This would be a real-life qualitative test, however, not repeatable unless you re-test with another sampling of “damaged” parts.

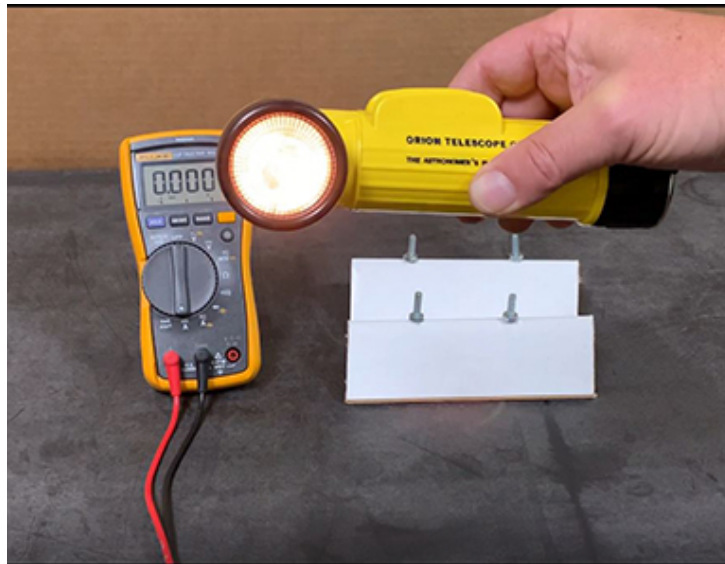
. . . . To be continued

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4. DeoxIT® WOWS and YouTube Videos:

4a. Flashlight:

Luckily, we found one flashlight that had not been previously treated with DeoxIT®.



Link to Video: [Flashlight Video](#)

Notice there are three videos. In the first video, the connections were treated with DeoxIT® and it seemed the current did not change. Although this flashlight was in working order it was not treated with DeoxIT® yet. I then realized I forgot to treat the bulb socket. The second video shows the bulb being treated with DeoxIT® and the current increased slightly. If the connections were more oxidized the delta change would have been

more significant. The Third video done by a person on YouTube™ showing the cleaning of a switch on a flashlight – lowering resistance / increasing voltage: <https://www.youtube.com/watch?v=OGvemNm4YRo>

It is clear from TEST 2c above that RESISTANCE DECREASE = CURRENT INCREASE = BETTER PERFORMANCE

4b. Flashlight Test Board:

Originally, this board was going to be used to do a comparison of the 5 products. The boards (5 boards) were put into a humidity chamber for 4 weeks. After noticing the inconsistency of the parts deterioration after exposure, we decided not to use them for the comparison test. For a WOW test, we were able to use this board for a demonstration to simulate a flashlight similar to the 4a test.



Link to Video: [Flashlight Test Board](#)

Notice before treatment no current and no light bulb illumination. After treatment, conductivity established and bulb illuminates.

RESISTANCE DECREASE = CURRENT INCREASE = BETTER PERFORMANCE

4c. YouTube Videos:

- a. **Applied Science explains and compares corrosion protection:**
<https://youtu.be/VpRrP3sqQLw>
- b. **Flashlight switch rejuvenation:**
<https://www.youtube.com/watch?v=OGvemNm4YRo>
- c. **Game cartridge edge connector:**
<https://www.youtube.com/watch?v=Bs0NsnFOAMM&feature=youtu.be>
- d. **Fix automotive keyless entry remotes:**
<https://www.youtube.com/watch?v=hSUf4IYqG9w>
- e. **LED flashlight fix:**
<https://www.youtube.com/watch?v=ax2FtwS72sA>
- f. **GameBoy fix:**
<https://www.youtube.com/watch?v=z8GdjXu19OI&list=PLohhMbFG2rxs9ArMRRIRv9rOyJFvm6kFB&index=44&t=0s>
- g. **Vintage audio equipment**
<https://www.youtube.com/watch?v=lnAWsrBD1tE&list=LLi8wFc8FipRo1rjc7nBzraA&index=13&t=21s>

h. Cleaning a \$25 Realistic STA 2100D receiver with DeoxIT | Perfect for turntables!

<https://www.youtube.com/watch?v=zAdqzVrRPGY&list=PLohhMbFG2rxs9ArMRRIRv9rOyJFvm6kFB&index=5&t=0s>

j. Fix a variac transformer

<https://www.youtube.com/watch?v=sCJWWPzlBq0&feature=youtu.be>

CAIG Site for DIY Videos: <https://caig.com/product-demonstrations/>

5. MATERIALS COMPATIBILITY:

While doing this test, it was noticed that some of the containers used to apply products to the test coupons started to distort. This led us to decide to discuss another key attribute of the DeoxIT® formula.

Ordinary contact cleaners, with or without a lubricant, rely on solvents to clean the surfaces. In order to do so, they can contain ingredients that have adverse effects on plastics, components and electronics.

- DeoxIT® D5 does not rely on solvents to “clean” the surface.
- DeoxIT® lifts oxides off the surface without removing metal (or changing the design characteristics of the connector),
- All without harm to plastics and electronics.