Advanced Cable Tester v2 Connector Module Guide

The modules used with your Advanced Cable Tester v2 (“ACTv2”) are high precision pieces of hardware. They are cable of measuring resistance at the milli-ohm level as well as assessing signal integrity at speeds in excess of 12 Gbps.

The proper use, care, cleaning, and storage are invaluable in ensuring accurate results when using your ACTv2 unit.

Why would my Connector Modules need cleaning?

Physical Appearance

Our experience has shown that in factory use, some customers experience erratic test results when Advanced Cable Tester v2 modules have been subjected to >5000 tests.

Micrographic examination of used modules indicate the deposition of foreign matter on the pins in the receptacles used within in the ACTv2 module.

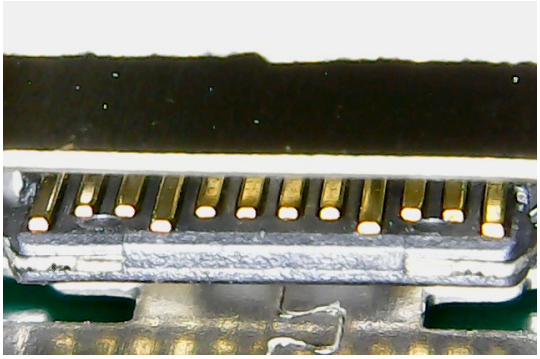

Figure 1: New USB Type-C module

In Figure 1, we see clean and shiny fingers in a receptacle (internal to the ACTv2 module). This unit is new and no deposits which could interfere with electrical conductivity are visible.

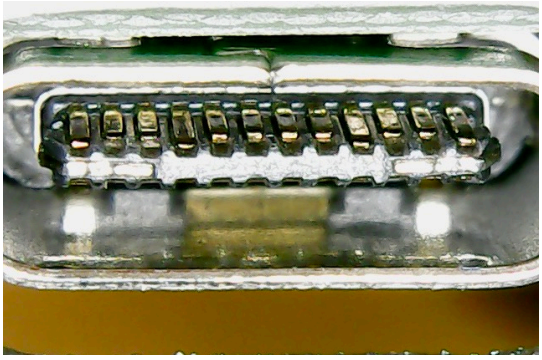

Figure 2: 9,000 insertions on a USB Type-C module

In Figure 2, we see a module which has been used in 9,000 tests. This used unit has visible black deposits which could interfere with electrical conductivity between the gold on the receptacle finger and the cable under test. Non-conductive foreign matter on the receptacle conductors would act as insulators, resulting in higher DC resistance ("DCR") measurements.

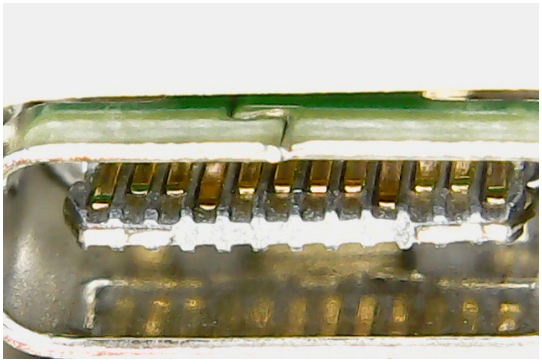

Figure 3: 9,000 insertions on a USB Type-C module after cleaning

In Figure 3, we see the same module after cleaning in a solvent. The entire module was immersed in the solvent, and then subjected to 2 minutes of ultrasonic cleaning per receptacle. The black deposits were dissolved and are no longer visible resulting in visibly clean metal contacts.

Impact on resistance measurements

In this experiment, the same cable was used to test the DCR of a new module, the used and uncleaned module shown in Figure 2, and the used and cleaned module shown in Figure 3.

For the electrical testing, the DCR was measured for the individual pins of GND and VBUS, as well as the shell to GND for each module port. Additionally, the resistance of the GND, VBUS, CC, and SBU through wires were considered. In total there were 22 measurements that involved pins with an expected value of <150 milli-ohms of resistance ("low DCR group"), and 6 measurements which involved through wires with an expected value of >1 ohm ("high DCR group").

What we found:

- The deposits visible in Figure 2 **did not substantively** impact the resistance for the high DCR group (PLUG 1 B5, PLUG 2 B5, B5 through, CC, SBU A8, SBU B8).
- The deposits visible in Figure 2 **did substantively** impact the resistance for the low DCR group (GND Cable, GND Cable with shells, Shield Cable, GND - Plug 1 Pin A1, GND - Plug 1 Pin A12, GND - Plug 1 Pin B1, GND - Plug 1 Pin B12, GND - Plug 2 Pin A1, GND - Plug 2 Pin A12, GND - Plug 2 Pin B1, GND - Plug 2 Pin B12, GND - Plug 1 shell to GND, GND - Plug 2 shell to GND, VBUS Cable, VBUS - Plug 1 Pin A4, VBUS - Plug 1 Pin A9, VBUS - Plug 1 Pin B4, VBUS - Plug 1 Pin B9, VBUS - Plug 2 Pin A4, VBUS - Plug 2 Pin A9, VBUS - Plug 2 Pin B4, VBUS - Plug 2 Pin B9).

The increase in resistance for the low DCR cohort averaged ~43 milliohms when comparing the new module versus the uncleaned 9,000 insertion module. For pin level resistance, shell to GND, VBUS through, and GND through the increase in resistance is significant versus the allowable threshold value because many of the pins/lines have maximum allowable values between 40 milli-ohms (pin level) and 167 mill-ohms (VBUS 3A cable through).

The increase in resistance for the high DCR cohort is relatively minor when compared to the allowable threshold value and the deposits did not impact the test results.

Solvent based cleaning lowered the resistance for the low DCR cohort by an average of 37 milli-ohms.

CONCLUSIONS:

Deposits occur during the cable testing process. Likely, when new cables are inserted into the module receptacle there is a small transfer of foreign material which builds up over multiple tests, ultimately resulting in a deposit, which can significantly impact the accuracy of the test.

The deposits can be easily removed with solvent based cleaning, effectively restoring the used module to a cleanliness level which is comparable to new modules.

Prevention and Elimination of foreign material deposits

How does foreign material get into the system?

The metal connectors, shields, and cable stock used in cable assembly are typically manufactured by a metal stamping or extrusion process.

Extrusion forces a pre-heated metal billet through a steel die at high pressure. After the extrusion is formed, the resultant long metal extrusion is allowed to cool via natural air draft or water quenching. The long extrusions are typically mechanically straightened and cut into the appropriate size pieces for the finished product. At this point, optionally, the cut-to-length product is then subject to further aging over various temperature profiles in an aging oven to optimize the characteristics of the metal.

Stamping can cut and/or shape a flat metal piece (usually a roll that has been extruded). In this process, a lubricated strip of sheet metal is run through a large mechanical press. Combination dies are capable of performing two metal processes that are required to process the proper size and shape for the metal product: (1) Blanking is the process of stamping a cut out. The result is a flat two dimensionally cut piece of metal. (2) Forming is the process of three dimensionally shaping the blank metal stamped in step (1). Blanking and forming require lubrication.

Both of the industrial metal processes indicated above are performed in standard metal manufacturing conditions. This environment is less clean than standard electronic manufacturing conditions. Additionally, the processes of quenching, forming, and blanking all contribute to the presence of surface foreign materials on/within the connectors. It is not general practice today to subject connectors to vigorous cleaning after manufacture; therefore, ***the metal manufacturing process is a vector for bringing foreign material into the clean ACTv2 modules.***

Each time a contaminated cable plug is inserted into the ACTv2 module, a small amount of the foreign matter is transferred to the metal fingers of the receptacle. The process of running current from the receptacles to the plugs and vice-versa "cooks" the foreign material, creating a black residue that doesn't easily scrape off with the insertion of a new plug into the receptacle. Over time, the residue builds until it is thick enough to impact the DCR testing.

How can I prevent this foreign material deposition?

There are two ways to prevent the deposition and "cooking" of the foreign material:

- Method 1: Prevent the deposition of the foreign material by solvent cleaning the connectors prior to assembly.
- Method 2: Clean the modules when they begin to show signs of deposition using a solvent with ultrasonic vibration.

Method 1 would need to be determined by the individual factories, who possess expertise in the connector manufacturing process and an understanding of the lubricants and quenching agents used. The author believes it is likely that acetone and isopropanol soaking of connectors with mild agitation would work, but this has not been verified in the Total Phase lab.

Method 2 has been determined to be effective in the Total Phase lab.

Method 2: Process for Cleaning

All steps should be performed in a well-ventilated area. Good lighting is required. All environmental and personal safety precautions should be followed when dealing with any solvents.

1. The module should be removed from the ACTv2 unit.
2. The front, top, and bottom of the faceplate should be cleaned with a cotton ball or soft lint free cloth dipped in acetone and optionally [additionally] a cotton ball/soft lint free cloth dipped in isopropanol. This step will remove any gross contamination, including hydrocarbon residue, permanent markers, sticker residue, etc*. If this step is not followed, higher levels of contamination will be spread on to the pins when the next steps are followed.*

3. A container which is large enough to fully immerse a connector module should be filled with pure acetone. It is recommended that the container be tall enough to prevent splashing in the next steps.
4. Immerse the module in the acetone bath. There is no need to remove the faceplate.
5. Insert the head of a Philips Ultrasonic Toothbrush into the acetone. *An ultrasonic brush is required because the bristles from the brush will not reach all areas inside the receptacle and the added agitation produced by the ultrasonic action will help in the cleaning process.*
6. Turn on the Ultrasonic Toothbrush and gently swab the outside of the receptacle with the nylon teeth while the ultrasonic cleaning is in progress. Make sure that you gently insert the bristles into the receptacle to ensure adequate agitation and gentle brushing. Brushing too aggressively may damage the interior of the receptacle; therefore, exercising proper caution is necessary.
7. After the cycle is complete, repeat the process for the second receptacle. The total cleaning time is approximately 2 minutes per receptacle, which is 4 minutes per module.
8. Remove the module from the acetone, and gently shake to remove any acetone drops which remain. Failure to do this could result in some contamination remaining on the pins when the acetone dries.
9. Allow to air dry and reach room temperature.
10. The module is now ready for continued production testing.
11. Optionally, the module may be cleaned with high quality isopropanol (chemical grade, not the grade found in pharmacies) as an extra step if the acetone cleaning was not sufficient (note, acetone alone was sufficient in our lab tests; however, the solubility of various contaminants may be different based upon your connector manufacturing process).

Module Wear

Module Life and Rating

All Total Phase ACTv2 connector modules are designed to provide accurate test results for up to 10,000 tests. We use the highest quality certified receptacles available and metallurgical testing has been conducted on the receptacles to ensure that under normal operation the thickness of the highly conductive gold layer is adequate to ensure good quality tests results.

In Figures 4 and 5, we see a magnified comparison of the pins on a new receptacle versus a receptacle with 9,000 insertions.

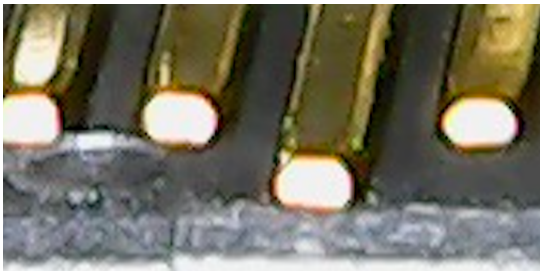

Figure 4: Enlargement of pins, new module

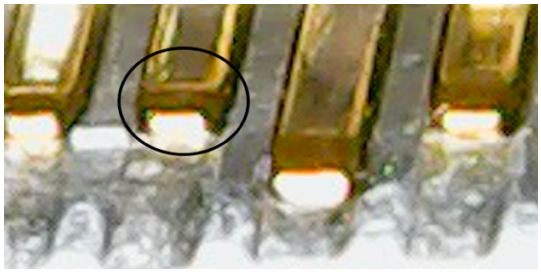

Figure 5: Enlargement of pins, 9,000 insertions

In Figure 4, we see a new module. The gold surface of the connector is clearly visible with no blemishes.

In Figure 5, we see a module which has been subjected to 9,000 insertions. Wear on the pins is evident in the circled area. The line and slight change in color is due to the scraping action that occurs each time when a cable is inserted into the module. When the highly conductive contact material is worn beyond specification, DCR results will become inaccurate.

The receptacles used in the ACTv2 modules are rated for 10,000 insertions, meaning we can be confident the conductivity is within the specified limits during the rated life of the module.

Beyond 10,000 insertions, it is not possible to be confident in the accuracy of the measurements. To prevent this uncertainty, your Advanced Cable Tester v2 is programmed to track the number of tests on each module. At 9,000 tests, your unit will warn that that the end of the module life is approaching. At 10,000 tests, your Advanced Cable Tester v2 will no longer perform tests with the worn module.

Module Care

Your ACTv2 modules are highly sensitive and precise components of your analytical infrastructure. Precise resistance measurements and high-speed signal integrity measurements require hardware in good condition, free of debris and mechanical damage.

In many factory environments, modules are exhausted in a short period of time. It is recommended to leave modules inserted in the ACTv2 unit whenever possible.

For some factory environments with lower test volumes and most laboratory applications, modules will be partially worn and then set aside for a different type of cable to be tested. Whenever possible, partially consumed modules should be stored in their original packaging, e.g. an anti-static bag with a desiccant pack, inserted within a bubble wrap. If the unit is going to be stored for a long period of time or is used in an environment where the module could be subjected to physical shock, the additional protection of a plastic or cardboard box to store all partially consumed modules is suggested as additional physical protection.

Summary

To keep your Advanced Cable Tester v2 in top condition and producing consistently accurate results, the care and maintenance of the ACTv2 connector modules is essential. The prevention of contamination and proper storage for modules is essential.

If circumstances cause foreign matter to be deposited on to the fingers of the ACTv2 module, it is important to periodically clean the debris from the module. The cleaning guide contained herein will produce consistent, high quality results without damage, ensuring you are able to use your modules for their entire rated life with confidence and accuracy.