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HLC® Connector Studies – Optical Return Loss & Multiple Mates

It is well known within the test and measurement industry that Optical Return Loss (ORL) degrades at a higher rate than Insertion Loss on a test cord that is actively being used. The ORL measurement is very sensitive to contamination, endface defects, and enface geometries, and has a tendency to drop off very quickly after a connector is plugged in repeatedly.

This set of tests was designed to compare the HLC laser termination process to the industry standard UPC connectors. When the HLC laser process occurs, the structure of the glass at the point of the cut is altered, and the resulting lens that is created is harder than the original glass. Through diamond tipped stylus testing done with Micro Photonics, we have determined that the HLC endface is in fact harder than a standard UPC endface – but what does that mean in terms of measurement integrity? The mating tests are designed to simulate high use and help us track the performance.

METHODS

For this set of tests, we used a custom built linear actuator setup that was designed by Megladon. The apparatus works in conjunction with a custom software package, letting a user set predefined mating conditions (how many mates, duration, extend/retract positions). A mate is defined as plugging two connectors together, then unplugging them. The idea is that a single mate simulates a test operator testing a single link, all else being equal. The linear actuator then carries out these connector mates without the need for further user interaction. This apparatus was built by Megladon to support our on-going durability testing efforts.

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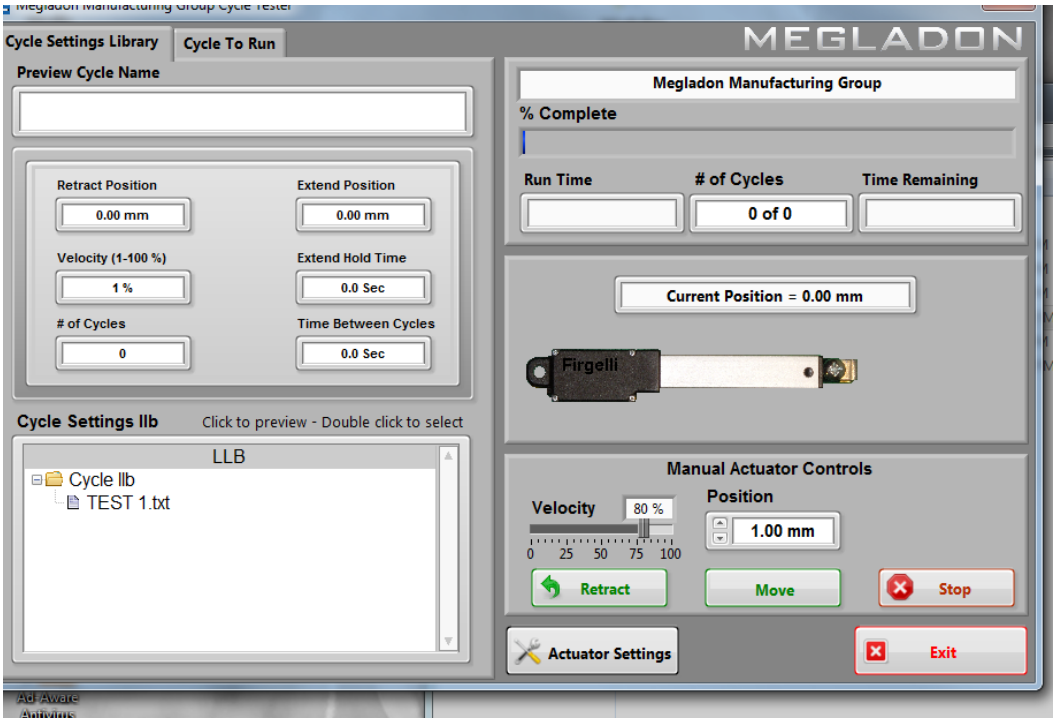

Screenshot of Actuator Software

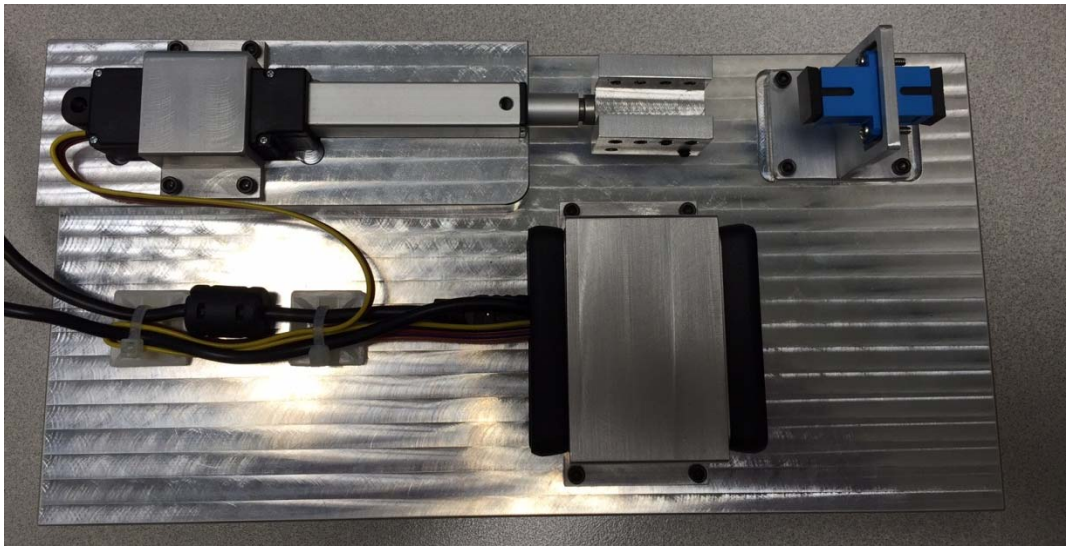

Photo of Linear Actuator Mating Tool

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The connector is held in place by a series of small set screws. Once the connector undergoes the necessary mating cycles, it can be removed from the holder and tested.

For this specific set of tests, we have focused on SM SC/UPC connectors. All IL and ORL measurements were done at two wavelengths, 1310/1550, on the EXFO IQS benchtop testing platform. All measurements were made with the same Test Reference Cord in use, which was UPC polished. The test cable was evaluated between all measurements to ensure that the endface was scratch free and free from contaminants to ensure the best possible ORL measurement.

The test took measurements after 50 mates from a HLC connector and a UPC connector. The connectors were placed in the fixture, mated 50 times, and then measured for their ORL performance values. This procedure was continued, and additional measurements were taken every 50 mates, up to 250 total. The mating connectors were clean - the purpose of the test was not to gauge the impact of contamination, but show degradation in ORL performance through exercising the endfaces. Because the connectors were clean and properly aligned, there was no measurable degradation in IL values for either connector at 250 mates. Resistance to damage from contamination and longevity will be studies in further experiment sets.
By the time of this report, eight HLC and eight UPC connectors had undergone the full 250 mates and had data recorded. In the test result section, there is a measurement for each connector at each 50 mate interval.

Test Results:

HLC - ORL 1310								
Mate #	**Set 1**	**Set 2**	**Set 3**	**Set 4**	**Set 5**	**Set 6**	**Set 7**	**Set 8**
Start	-69.64	-65.09	-66.03	-62.14	-61.86	-62.6	-63.53	-61.79
50	-67.41	-62.36	-62.32	-61.37	-59.47	-60.42	-61.47	-60.15
100	-62.33	-64.57	-60.69	-59.73	-58.7	-58.39	-60.11	-59.1
150	-57.99	-58.95	-58.92	-57.43	-57.35	-57.33	-58.27	-56.42
200	-52.29	-56.19	-58.18	-55.26	-55.36	-55.85	-56.33	-55.34
250	-52.06	-55.76	-56.34	-53.18	-55.11	-53.26	-52.54	-53.01

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UPC - ORL 1310								
Mate #	**Set 1**	**Set 2**	**Set 3**	**Set 4**	**Set 5**	**Set 6**	**Set 7**	**Set 8**
Start	-57.46	-54.63	-54.55	-55.24	-57.06	-55.55	-57.69	-59.74
50	-56.97	-54.34	-53.99	-53.86	-56.34	-55.16	-56.19	-57.39
100	-54.71	-54.02	-53.13	-52.7	-55.19	-54.8	-55.78	-55.64
150	-52.66	-53.43	-52.09	-51.54	-54.11	-53.11	-53.84	-53.79
200	-51.42	-52.77	-51.73	-50.63	-54.79	-52.07	-52.6	-51.29
250	-51.35	-52.36	-48.92	-48.66	-53.61	-51.29	-50.77	-49.65
HLC - ORL 1550								
Mate #	**Set 1**	**Set 2**	**Set 3**	**Set 4**	**Set 5**	**Set 6**	**Set 7**	**Set 8**
Start	-63.07	-72.42	-67.55	-63.83	-63.63	-63.91	-64.39	-63.52
50	-62.23	-70.9	-64.73	-62.56	-60.11	-61.39	-62.63	-61.33
100	-60.04	-62.15	-61.36	-60.55	-59.38	-60.07	-61.59	-59.95
150	-54.73	-57.25	-60.13	-58.16	-58.19	-58.51	-59.74	-57.7
200	-53.28	-57.5	-59.76	-57.01	-57.83	-56.12	-57.38	-56.22
250	-52.96	-56.13	-57.61	-54.76	-57.04	-54.06	-53.81	-53.97
UPC - ORL 1550								
Mate #	**Set 1**	**Set 2**	**Set 3**	**Set 4**	**Set 5**	**Set 6**	**Set 7**	**Set 8**
Start	-59.7	-56.79	-56.15	-56.79	-58.87	-56.66	-59.42	-60.23
50	-57.24	-56.17	-54.95	-55.72	-57.86	-56.35	-58.3	-59.13
100	-55.48	-55.17	-53.97	-53.22	-56.15	-55.15	-56.61	-56.53
150	-53.17	-54.39	-53.23	-52.63	-55.73	-54.86	-54.63	-54.16
200	-52.35	-54.09	-51.96	-51.7	-55.87	-52.98	-53.19	-53.06
250	-52.54	-53.8	-50.73	-49.79	-54.29	-53.01	-51.27	-50.92

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INITIAL CONCLUSIONS

From the data set we can infer the following:

1) The HLC connectors have a lower ORL at the onset of the tests than the UPC
    a. -64.08 dB @1310 (vs. -56.49 dB UPC)
    b. -65.29 dB @1550 (vs. -58.07 dB UPC)

2) The HLC connectors stay within spec longer than the UPC connectors
    a. Industry accepted performance spec for ORL is -55 dB

3) After 200 mates, HLC connectors have on average -3.0dB lower ORL than UPC connectors

On average, the HLC connectors lasted to between 200-250 mates before falling below the -55 dB threshold. Most UPC connectors fell below that threshold at 100-150 mates. The results are consistent across both 1310nm and 1550nm wavelengths.

WHY IS THIS RELEVANT?

Test reference cords are a crucial part of any testing solution, and their quality directly impacts the integrity of the test data gathered in the field. Generally speaking, the value of this cord is difficult for the operator to perceive, until they no longer get the passing results they expect.

This presents a couple of ideas that are not widely accepted by many of our customers:

1) A test cord is a consumable, and will wear out with repeated use
2) The test results taken with a new cord will be better than those generated with an old cord.

These ideas are undeniable, but do not necessarily cause operators to plan/budget for or purchase additional test cords. Keep in mind that all of this data is on the logarithmic scale. In the initial conclusions it states that “After 200 mates, HLC connectors have on average -3.0dB lower ORL than UPC connectors.” In the context of the logarithmic scale, -3.0dB is approximately 50% less power measured. In this case, the measured power level of the HLC ORL is 50% lower than that of the UPC connector. At 1310nm, the UPC connector measured -56.49 dB on average, which is about 5.5X higher than the -64.08 measured on the HLC connectors initially.

The HLC connectors provide additional headroom for sustained use compared to the UPC connectors, allowing for longer use in testing. It is not a solution that solves the problems of long term cable durability, but provides an incremental improvement that allows for an operator to take measurements within spec for a longer period of time.