Parker Chomerics

TEST SERVICES

AN EVALUATION OF THE TRANSFER IMPEDANCE OF PARKER CHOMERICS CHO-SEAL EMI SHIELDING ELASTOMERS PER CHO-TP10

Date: January 4, 2010

Test Report Number: SR5538.10 / TR 1046 EN January 2010
IN ACCORDANCE WITH CHO-TP10

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1 General

1.1 Purpose

Conductive EMI gaskets are used to seal apertures in electronic enclosures against leakage of electromagnetic radiation. Metal-filled homogeneously conductive elastomers are one type of EMI gaskets used for this purpose. Conductive elastomers consist of small metal particles, typically in the range of 30 to 150 microns, dispersed within an elastomer binder system. Typical metal fillers include silver, silver plated materials (e.g., copper, glass, aluminum, nickel), nickel, nickel plated materials (e.g., aluminum, graphite and glass), and carbon. Examples of typical binders include silicone and fluorosilicone based resin systems.

The purpose of this document is to report the transfer impedance of Parker Chomerics Ni/Al and Ag/Al filled CHO-SEAL materials against chromate treated surfaces before and after environmental exposure per Chomerics Test Procedure CHO-TP10 Revision Date 12/03/2009, The Test Method to Measure the Transfer Impedance Performance of EMI Gaskets. Chomerics Test Procedure CHO-TP10 was created to reflect the requirements of SAE ARP 1705 Rev. A 2006-04: Aerospace Recommended Practice Coaxial Test Procedure to Measure the RF Shielding Characteristics of EMI Gasket Materials, June 1981, Revised April 2006.

Although this evaluation does not replicate the mechanical and/or electrical performance of a gasket in an actual electronic enclosure, it does allow for comparative evaluations between gasket materials using a standardized setup and test procedure. For this particular evaluation, Ni/Al CHO-SEAL is represented by the molding grade version of CHO-SEAL 6502, and Ag/Al CHO-SEAL is represented by the molding grade version of CHO-SEAL 1298.

The data obtained from these tests may or may not be equivalent to a gasket performance when installed in an actual enclosure (application). Variables such as metal surface treatment, gasket deflection, flange configuration, fastener spacing, as well as the source, amplitude, and frequency of electromagnetic fields all play a part in the shielding effectiveness of a gasket system installed in an electronic enclosure. Care should be taken in applying the absolute values obtained from these tests to other gasket/ flange geometries or enclosure designs.

All testing was performed by Chomerics Test Services of Woburn, Massachusetts over the period of two months from July 2009 to August 2009.

1.2 Administrative Information

1.2.1 Test Facility

The Parker Chomerics test facility operates under the current revision of Chomerics Test Services Quality Assurance (QA) Manual Document Number QA002.

The QA Manual has been constructed to reflect a quality program in accordance with the requirements of the National Institute of Standards and Technology (NIST), ISO 9002, ISO Guide 25, NIST Handbook 150, EN 45001, MIL-I-45208A, MIL-STD-461D, 462D and Chomerics Test Services Quality Assurance Program (QAP).
The QA Manual outlines and describes the procedures for establishing and maintaining the quality of analysis, research, inspection, and testing within Chomerics Test Service (CTS).

This test report does not represent an endorsement by the U.S. Government.

The results and/or conclusions within this test report refer and/or apply only to the unit(s) tested as defined by this report.

Measurements performed for this test are traceable to the National Institute of Standards and Technology (NIST) based on the fact that all test equipment used for the measurements were previously calibrated using standards traceable to NIST.

The system amplitude accuracy for the measurements made during the transfer impedance testing was ±3dB. Chomerics Test Services measurement uncertainty calculations are available for review upon request.

1.2.2 Equipment Calibration

The calibration of Chomerics test facility equipment is controlled under the current revision of Chomerics Laboratory Test Equipment Calibration Manual Document Number QA001.

The test equipment used throughout this test sequence conforms to laboratory calibration standards, ANSI/NCSL Z540-1, traceable to the National Institute of Standards and Technology (NIST). The date of the last calibration is listed in each test section for the applicable equipment.

We certify that the test equipment used to perform this test was in calibration at the time of the test and are calibrated per ANSI/NCSL Z540-1 at least once per year.

1.2.3 Test Personnel

The test personnel performing or supervising the tests are accredited by the National Association of Radio and Telecommunications Engineers, Inc. (NARTE) as Certified Electromagnetic Compatibility Engineers (N.C.E.) and Technicians (N.C.T.).

2 Test Set-Up

2.1 Test Site Description

All transfer impedance measurements were performed at Parker Chomerics Test Services, 84 Dragon Court, Woburn, Massachusetts.

2.2 Test Plate Sets

The transfer impedance test plate sets used for this evaluation consist of two 6061-T6 aluminum plates manufactured to the specifications detailed in CHO-TP10 Revision Date 12/03/2009 and SAE ARP 1705 Rev. A 2006-04. The first plate, referred to as the test base plate, is illustrated in Figure 1. The 6.00 inch diameter, 0.500 inch thick cylindrical plate is used to hold the RF input connector and serves as the base surface physical pressed to the test jig housing. The bolt pattern consists of three equally spaced 1/4-20 tap through holes used to mate the plate sets together.

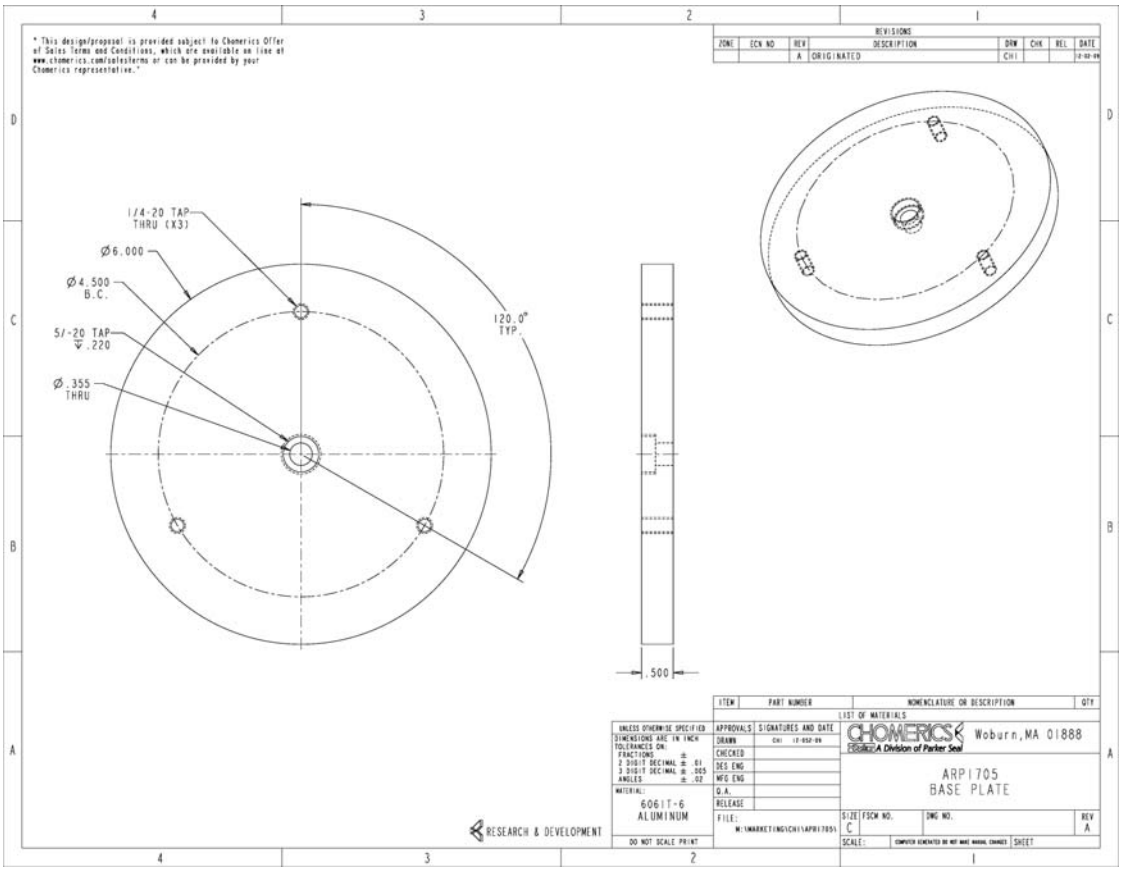

Figure 1 : CHO-TP10 Test Base Plate

The second cylindrical plate, referred to as the test contact plate (Figure 2), is 5.000 inch in diameter, 0.250 inch thick and is also made from 6061-T6 aluminum. The bolt pattern of this plate matches that of the base plate, together they form a test plate set.

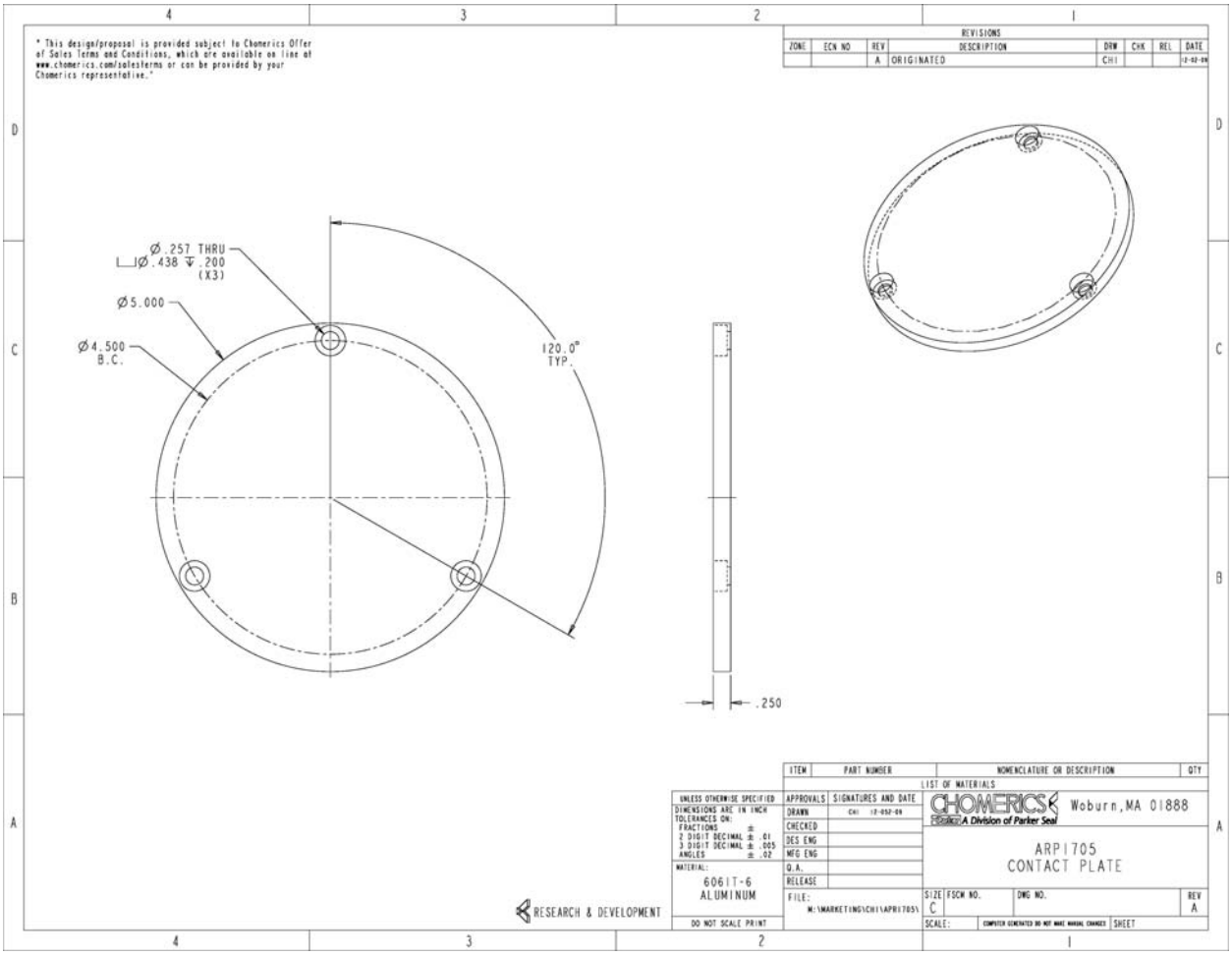

Figure 2 : CHO-TP10 Test Contact Plate

The following chromate conversion coating flange treatments were evaluated:

- MIL-C-5541, Class 3 Trivalent Chromate
- MIL-C-5541, Class 3 Hexavalent Chromate

2.3 Test Jig

The transfer impedance test jig (Figure 3) was manufactured to the specifications detailed in CHO-TP10 Revision Date 12/03/2009 and SAE ARP 1705 Rev. A 2006-04.

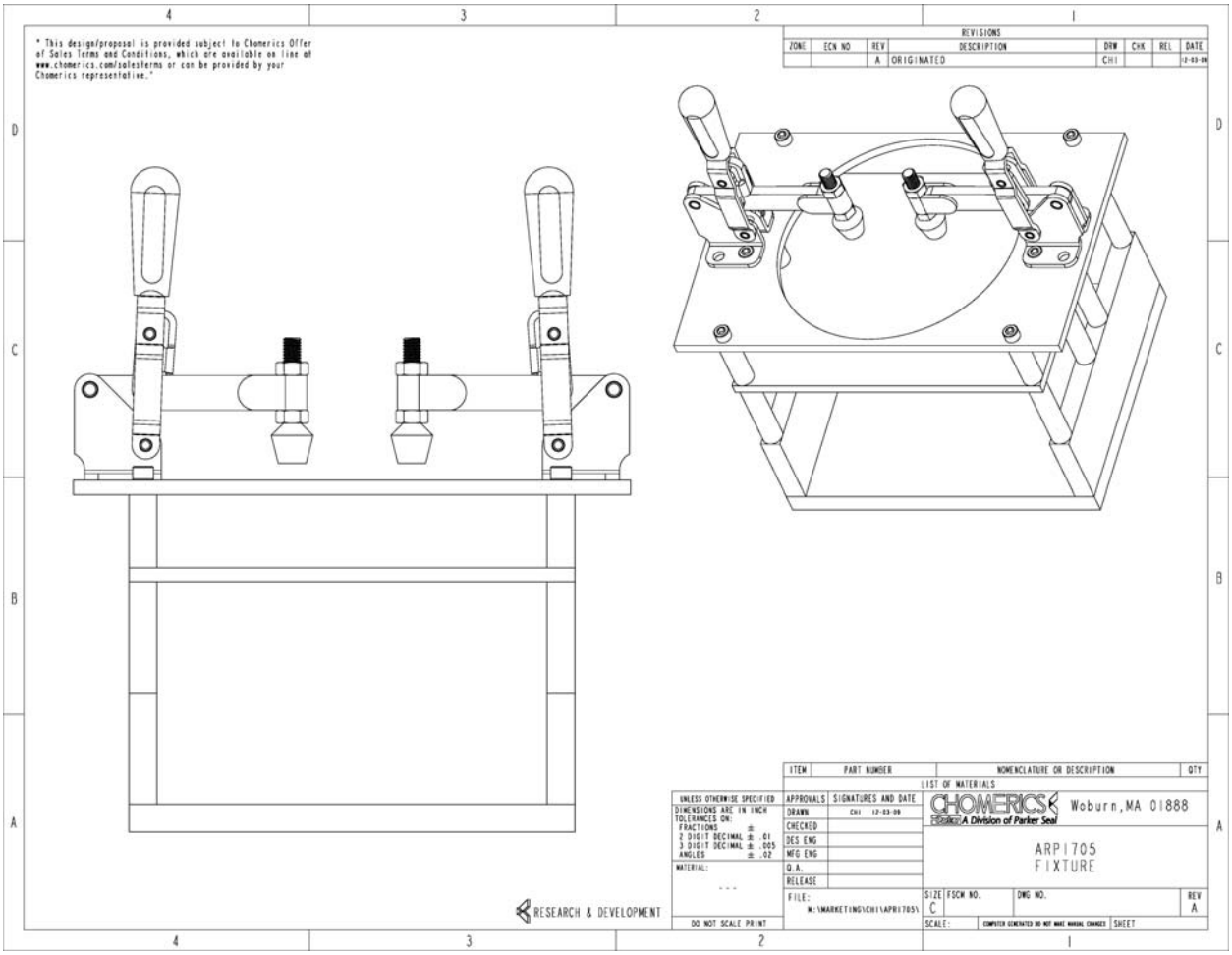

Figure 3 : SAE ARP 1705 Transfer Impedance Test Jig

2.4 Fixture Hardware

In addition to the test plates, Ultem 1000 round spacer washers were used as compression stops to target a nominal gasket deflection of 13.1% when the plate sets are fully assembled. The washers, which have an outside diameter of 0.750” and an inside diameter of 0.257”, are designed to fit around the bolt holes on the

plate sets and prevent uneven deflection in regions adjacent to the bolts. Three spacer washers were used per test plate set, one per bolt hole.

1/4-20 0.500 inch long Ultem 1000 socket head cap screws were used per test plate set to bolt the test base and contact plates together.

5/8-24 0.500 inch long Ultem 1000 slotted flat screw was used to keep the threaded RF input base plate port free of moisture and foreign debris.

2.5 Test Samples

The CHO-SEAL gasket test samples were compounded and manufactured by trained operators per the approved manufacturing process instructions. The test sample profile consisted of a Solid "D" cross-section with nominal measurements of 0.175 inch in height by 0.178 inch in width (Figure 4). The gasket configuration for the test set-up consisted of two 3.000 inch long cut to length strips per test plate set as specified by CHO-TP10.

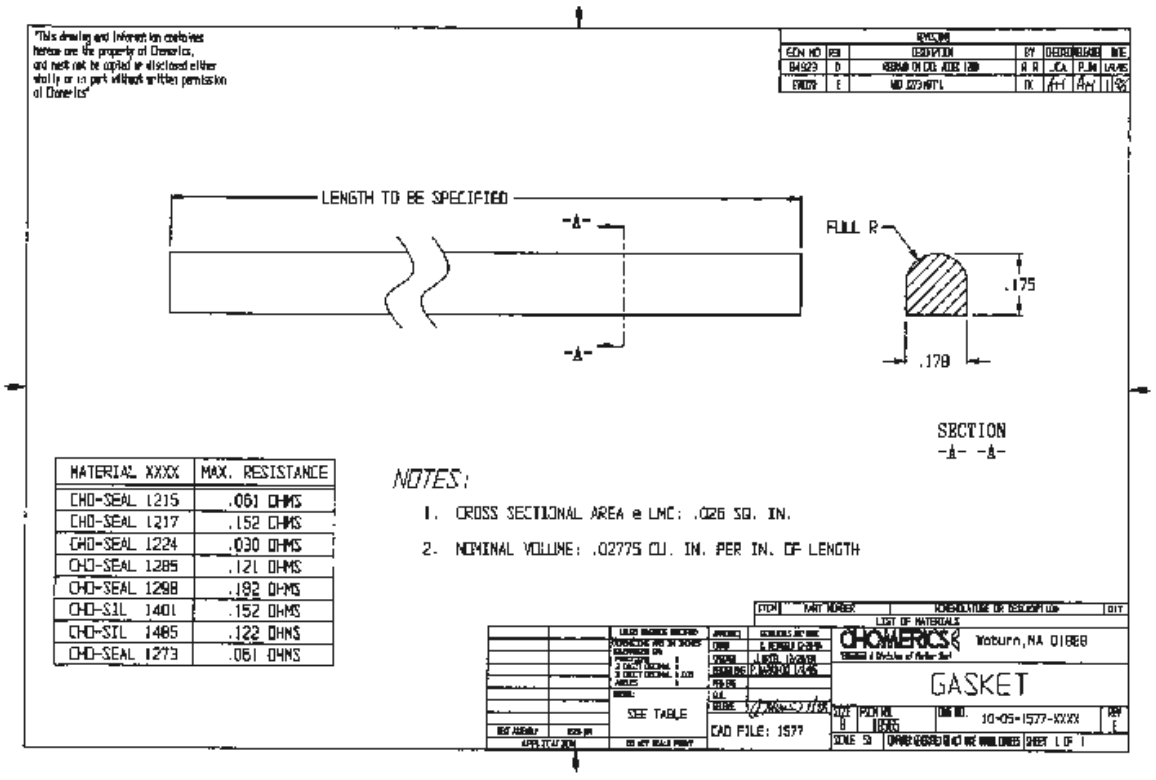

Figure 4 : Drawing of Solid "D" Profile

3 Test Plate Set Assembly

3.1 Equipment List

Table 1 : Equipment List for CHO-TP09 Test Fixture Assembly

Test Fixture Assembly Equipment	Asset #	Serial #	Calibration Schedule	Last Cal Date
Mitutoyo Model ID-C125TB Height Gage	N/A	801125	6 Months	Mar-09
Bosch Litheon - Compact Tough 18V Cordless Drill	N/A	N/A	N/A	N/A

Table 2 : CHO-TP09 Test Plate Hardware – One Complete Set

Hardware Description	QTY
CHO-TP10 Test Base Plate	1
CHO-TP10 Test Contact Plate	1
0.500” Long, 5/8 – 24 Thread Ultem 1000 Slotted Set Screw (Flat)	1
0.750” OD, 0.257” ID Ultem 1000 Spacer / Shim (Varying Thickness)	3
0.500” Long, 1/4 – 20 Thread Ultem 1000 Socket Head Cap Screw	3

3.2 Assembly Procedure

Using a height gage, two height measurements were made with every 3.000 inch sample. Based on the mean height of from the two strips used per test plate set, the shim thickness was selected to achieve a nominal deflection of 13.1% when the test plate set was fully assembled. The selected shim thickness was also verified at the extreme minimum and maximum height measurements within the sample population to ensure that the deflection would be no less than 8.2% and no greater than 16.7% at any point along the gasket.

Prior to assembly, all surfaces of the test plate sets were wiped down with an isopropyl alcohol soaked rag and allowed to air dry for five minutes. Once dry, the test plate sets were assembled by laying the base plate on a flat surface with the RF input facing downward and installing the appropriate shims around the three perimeter bolt holes. With the shims in place, the gasket strips were installed with the flat side seated on the test base plate. The gasket configuration consisted of two 3.000 inch long strips situated parallel to each other equally spaced between the center RF connector hole and the three perimeter bolt holes.

The test contact plate was then screwed to the test base plate frame using three socket head cap screws referenced in Section 2.3 above. The screws were tightened as much as possible to the compression stops without stripping, stretching or breaking. Figure 5 illustrates the gasket configuration of an assembled CHO-TP10 test plate set.

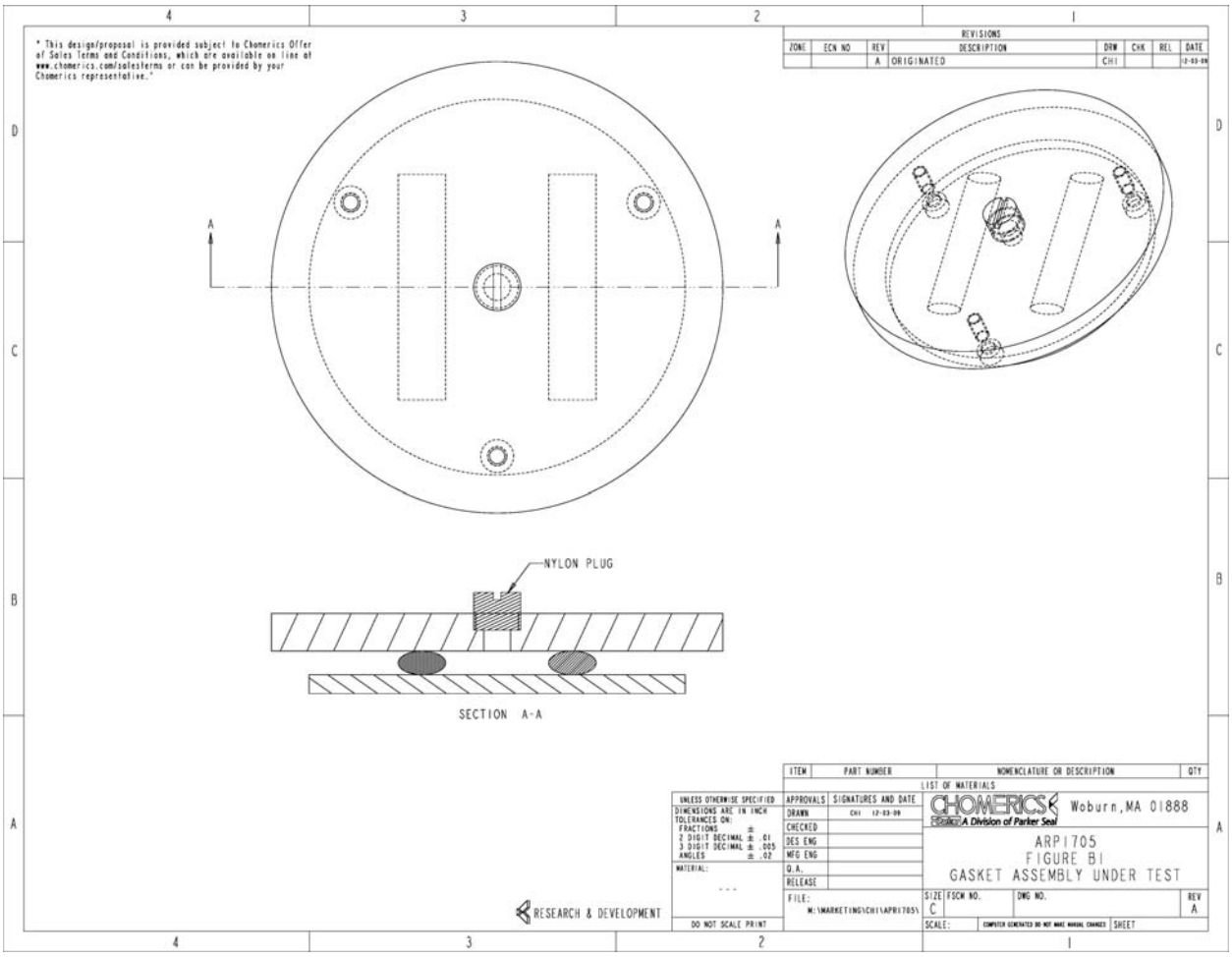

Figure 5 : CHO-TP10 Gasket Configuration – Assembled Test Plate Set

4 Environmental Exposure

4.1 Equipment List

Table 3 : Environmental Aging Equipment

Environmental Aging Equipment	Asset #	Serial #	Calibration Schedule	Last Cal Date
Dry Heat Oven: Blue M D-3992-Q	N/A	18A322	12 Months	Aug-08
Humidity Chamber: CSZ ZH-8-1-H/AC	N/A	Z0043465	12 Months	Mar-09

4.2 Exposure Conditions

Table 4 : Environmental Aging Exposure Conditions

Environmental Exposure	Dwell Conditions	Dwell Duration
Static Dry Heat	125°C +/- 1°C	1,000 Hours
Static Heat and Humidity	85°C +/- 1°C and 85% RH +/- 5% RH	1,000 Hours

4.3 Overview of Test Plate Sets: Flange Treatments and Exposure Conditions

Table 5 : Summary of Test Plate Set Flange Treatments Evaluated per Environmental Condition

	MIL-C-5541, Class 3	
	Trivalent Chromate	Hexavalent Chromate
Static Dry Heat	4	4
Static Heat and Humidity	4	4

5 Tests Performed – Transfer Impedance

5.1 Equipment List

Table 6 : Transfer Impedance Test Equipment

Test Equipment	Asset #	Serial #	Calibration Schedule	Last Cal Date
Chomerics Test Services 1705 Test Jig	N/A	N/A	N/A	NCR
Agilent Signal Generator	3326A	2519A00753	12 Months	Dec - 08
Agilent Signal Generator	83620B	3844A00955	12 Months	Jan - 09
Agilent Spectrum Analyzer	E4401B	My41440274	12 Months	Sep - 08
Agilent Pre-Amplifier	8447F	2805A03022	12 Months	Jan - 09

*NCR = No Calibration Required

5.2 Test Method

Parker Chomerics Test Method CHO-TP10 Revision Date 12/03/2009, The Test Method to Measure the Transfer Impedance Performance of EMI Gaskets, was used to evaluate the transfer impedance of CHO-SEAL 6502 and CHO-SEAL 1298 before and after exposure to accelerated environmental aging. Chomerics Test Procedure CHO-TP10 was created to reflect the requirements of SAE ARP 1705 Rev. A 2006-04: Aerospace Recommended Practice Coaxial Test Procedure to Measure the RF Shielding Characteristics of EMI Gasket Materials, June 1981, Revised April 2006.

Each material was evaluated at the following frequencies: 10kHz, 20kHz, 40kHz, 60kHz, 80kHz, 100kHz, 200kHz, 400kHz, 600kHz, 800kHz, 1MHz, 2MHz, 4MHz, 6MHz, 8MHz, 10MHz, 20MHz, 40MHz, 60MHz, 80MHz, 100MHz, 200MHz, 400MHz, 600MHz, 800MHz, and 1GHz.

One test plate set was evaluated at a time by first performing a reference signal measurement at the frequencies detailed above. To obtain the input voltage to the test jig, the three cables in the figure were daisy chained together and connected directly to the spectrum analyzer from the signal generator, bypassing the test jig as shown in Figure 6. With the signal generator output voltage held constant, the spectrum analyzer voltage level was recorded for each frequency under test.

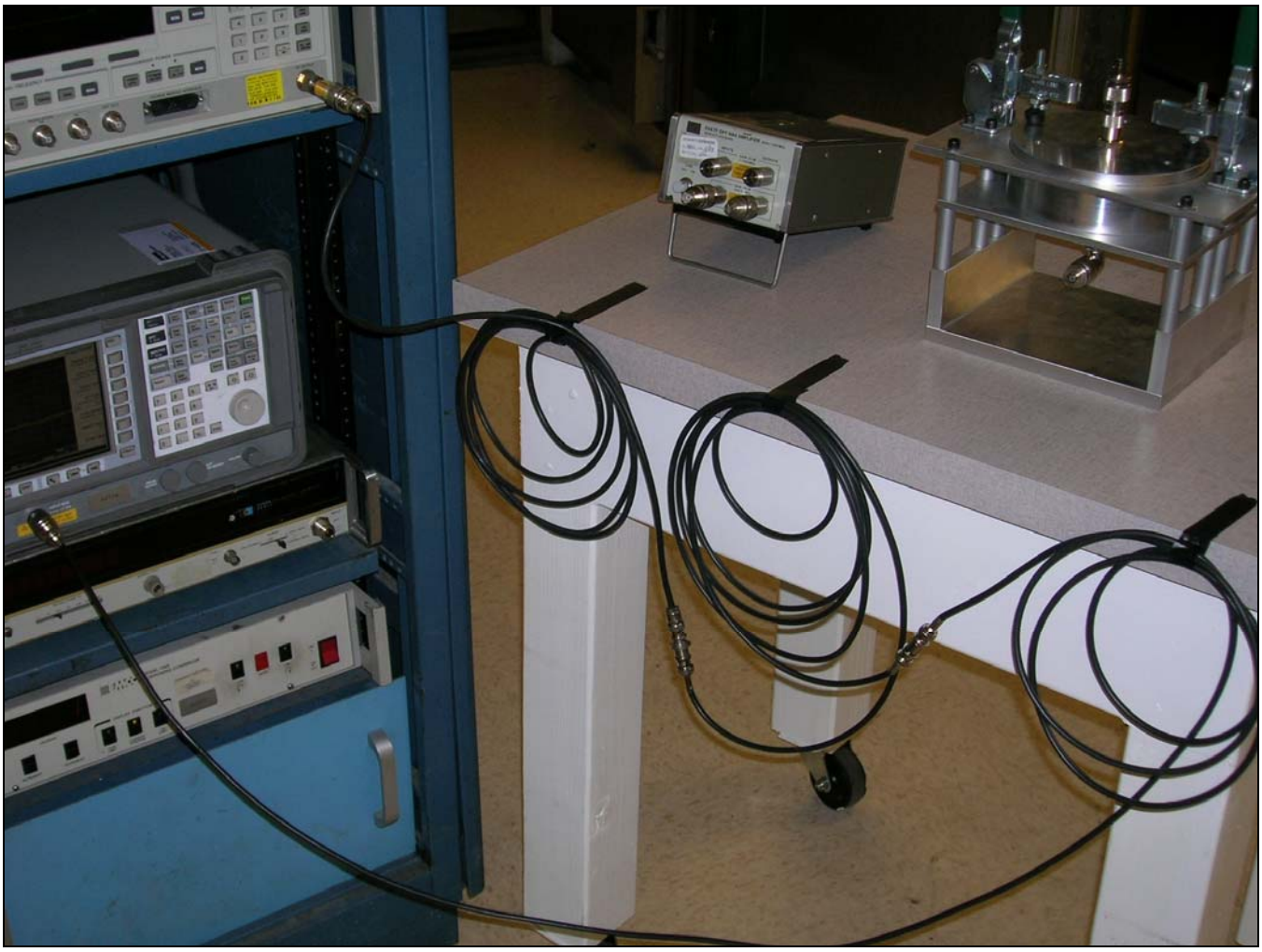

Figure 6 : CHO-TP10 Transfer Impedance Reference Signal Measurement Test Set-Up

Once the reference signal measurements were performed, the fully assembled test plate set was installed in the test jig. Final signal measurements were performed on the un-aged test plate sets at the same frequencies used for the reference signal measurements. The final measurement test set-up is detailed in Figure 7. Note the use of the optional pre-amplifier at the input to the spectrum analyzer.

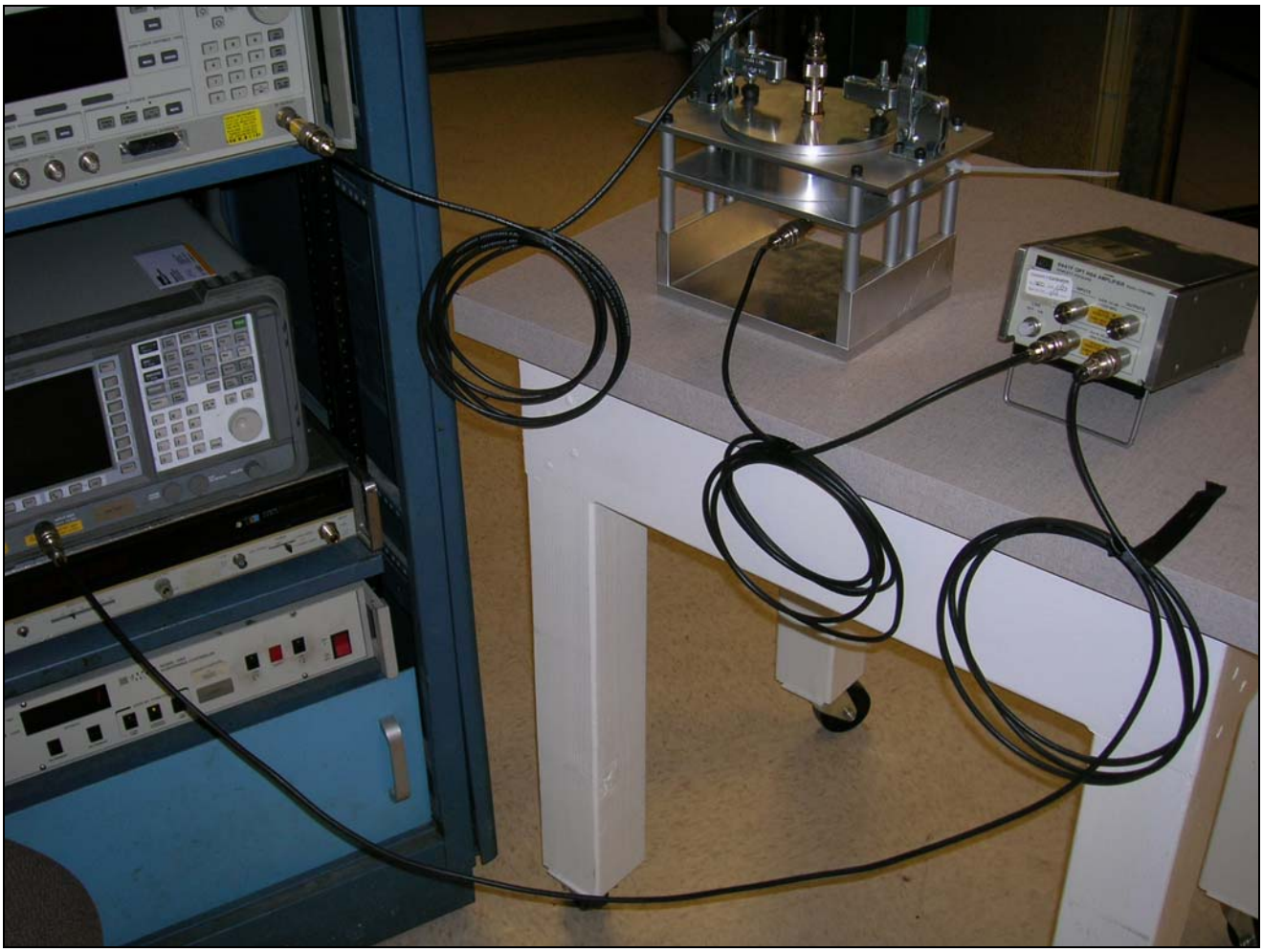

Figure 7 : CHO-TP10 Transfer Impedance Final Signal Measurement Test Set-Up

Once the final signal measurements were performed, the test plate sets were subjected to one of the two environmental exposure dwell conditions listed in Table 4.

Following environmental exposure, the aged test plate sets were allowed to re-acclimate to ambient conditions for a minimum of 10 hours prior to re-testing. Final signal measurements were then repeated for each aged test plate set.

5.3 Experimental Results

Data Sheet 1 : Ni/Al CHO-SEAL - Initial Baseline, 1,000 Hours @ 125°C Dry Heat, 1,000 Hours @ 85°C / 85%RH

TRANSFER IMPEDANCE TEST DATA

Customer:	Parker Chomerics R&D	**Date:**	01/04/2010
Product Tested:	Ni/Al CHO-SEAL	**Test No.:**	1
Tested by:	Bill Couture	**Test Spec.:**	TP-10
R&D Reference:	Initial Baseline, 1,000 Hours @ 125°C Dry Heat, 1,000 Hours @ 85°C / 85%RH		

Frequency	Zt Initial Baseline	Zt 1,000 Hr @ 125°C Dry Heat	Zt 1,000 Hr @ 85°C / 85%RH
(MHz)	(Ω-cm)	(Ω-cm)	(Ω-cm)
0.01	0.624	0.898	1.388
0.02	0.496	0.712	1.257
0.04	0.453	0.628	1.208
0.06	0.444	0.609	1.200
0.08	0.442	0.602	1.195
0.10	0.444	0.597	1.186
0.20	0.454	0.603	1.192
0.40	0.460	0.607	1.193
0.60	0.461	0.606	1.191
0.80	0.457	0.600	1.183
1	0.455	0.598	1.183
2	0.427	0.573	1.164
4	0.390	0.529	1.115
6	0.366	0.495	1.043
8	0.361	0.477	0.986
10	0.364	0.473	0.951
20	0.503	0.611	1.000
40	0.892	0.901	1.081
60	1.151	1.181	1.165
80	1.706	1.701	1.540
100	2.085	2.193	1.904
200	3.788	3.897	3.326
400	9.135	9.326	7.974
600	15.590	15.891	13.860
800	28.025	27.781	24.910
1,000	58.271	61.538	57.048

Comments:

1) Data averaged from eight test samples.
2) Test data taken over a two month period.

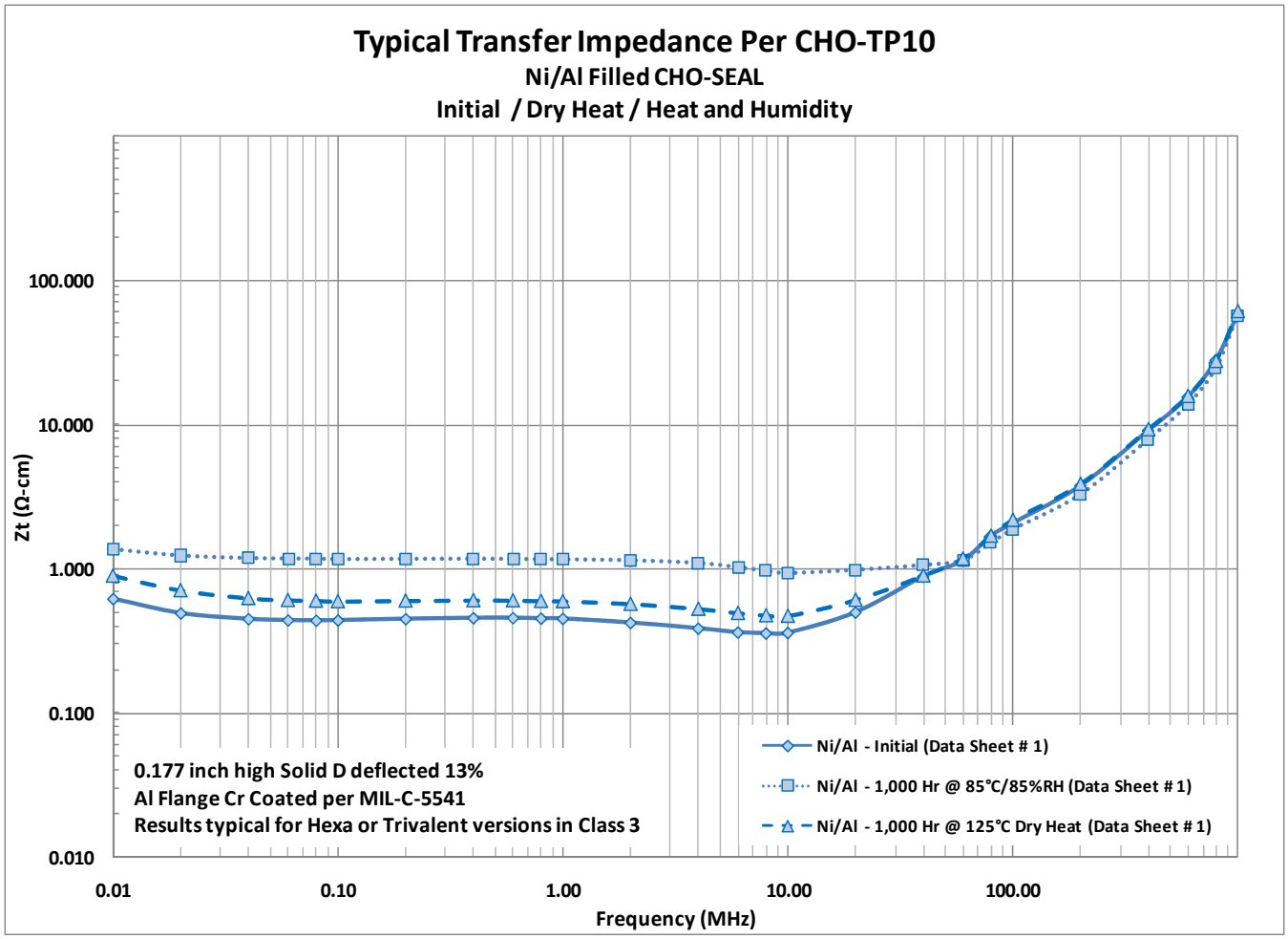

Figure 8: Transfer Impedance: Ni/Al CHO-SEAL - Initial / Dry Heat / Humidity

Data Sheet 2 : Ag/Al CHO-SEAL - Initial Baseline, 1,000 Hours @ 125°C Dry Heat, 1,000 Hours @ 85°C / 85%RH

TRANSFER IMPEDANCE TEST DATA

Customer: Parker Chomerics R&D
Product Tested: Ag/Al CHO-SEAL
Tested by: Bill Couture
R&D Reference: Initial Baseline, 1,000 Hours @ 125°C Dry Heat, 1,000 Hours @ 85°C / 85%RH

Date: 01/04/2010
Test No.: 1
Test Spec.: TP-10

Frequency	Zt Initial Baseline	Zt 1,000 Hr @ 125°C Dry Heat	Zt 1,000 Hr @ 85°C / 85%RH
(MHz)	(Ω-cm)	(Ω-cm)	(Ω-cm)
0.01	5.711	12.175	118.043
0.02	6.037	12.582	113.135
0.04	6.217	12.728	113.330
0.06	6.234	12.797	114.098
0.08	6.240	12.819	114.481
0.10	6.260	12.750	114.038
0.20	6.292	12.752	114.656
0.40	6.306	12.688	114.598
0.60	6.305	12.633	114.649
0.80	6.294	12.549	114.150
1	6.332	12.560	114.516
2	6.271	12.479	115.206
4	6.195	12.356	114.949
6	6.012	11.987	110.473
8	5.954	11.654	106.021
10	5.945	11.469	102.939
20	6.628	12.779	81.777
40	7.162	12.555	70.033
60	6.604	11.038	58.336
80	7.652	12.065	55.667
100	8.048	12.485	50.175
200	8.529	10.938	38.530
400	13.099	11.845	18.556
600	18.913	14.559	13.199
800	33.009	25.231	23.331
1,000	67.846	55.658	62.713

Comments:

1) Data averaged from eight test samples.
2) Test data taken over a two month period.

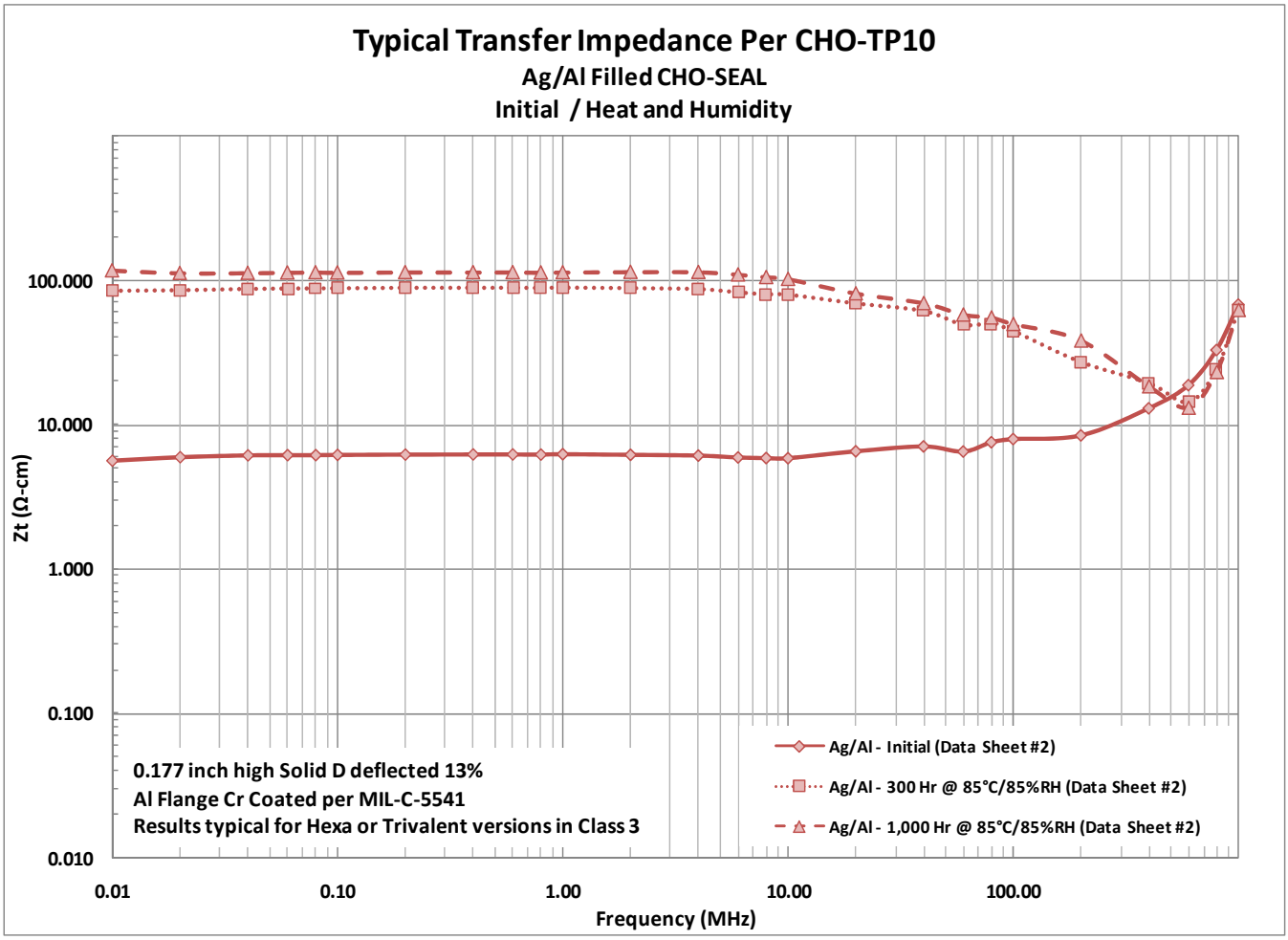

Figure 9: Transfer Impedance: Ag/Al CHO-SEAL - Initial / Dry Heat / Humidity

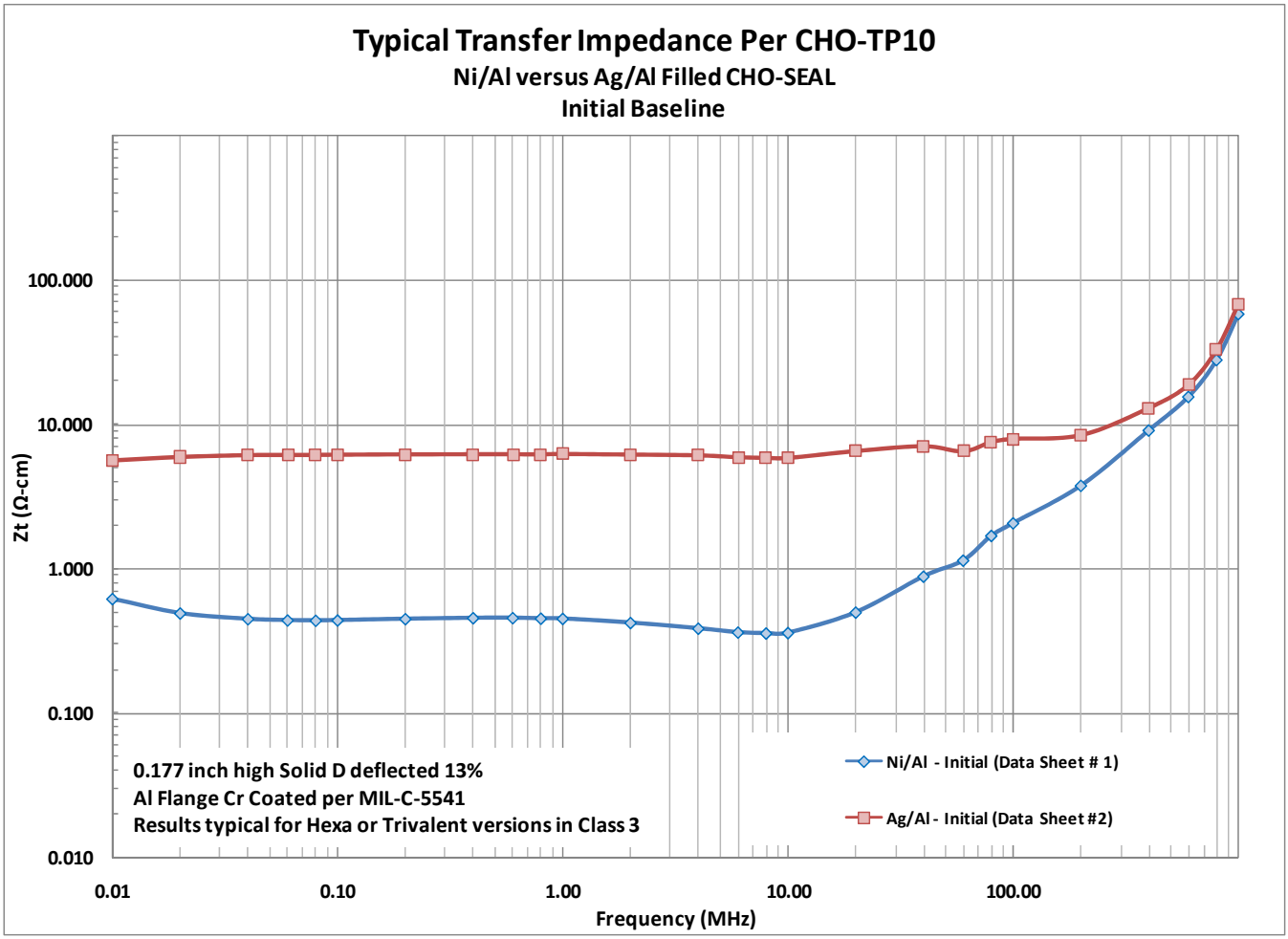

Figure 10: Transfer Impedance Comparison: Ni/Al vs. Ag/Al - Initial Baseline

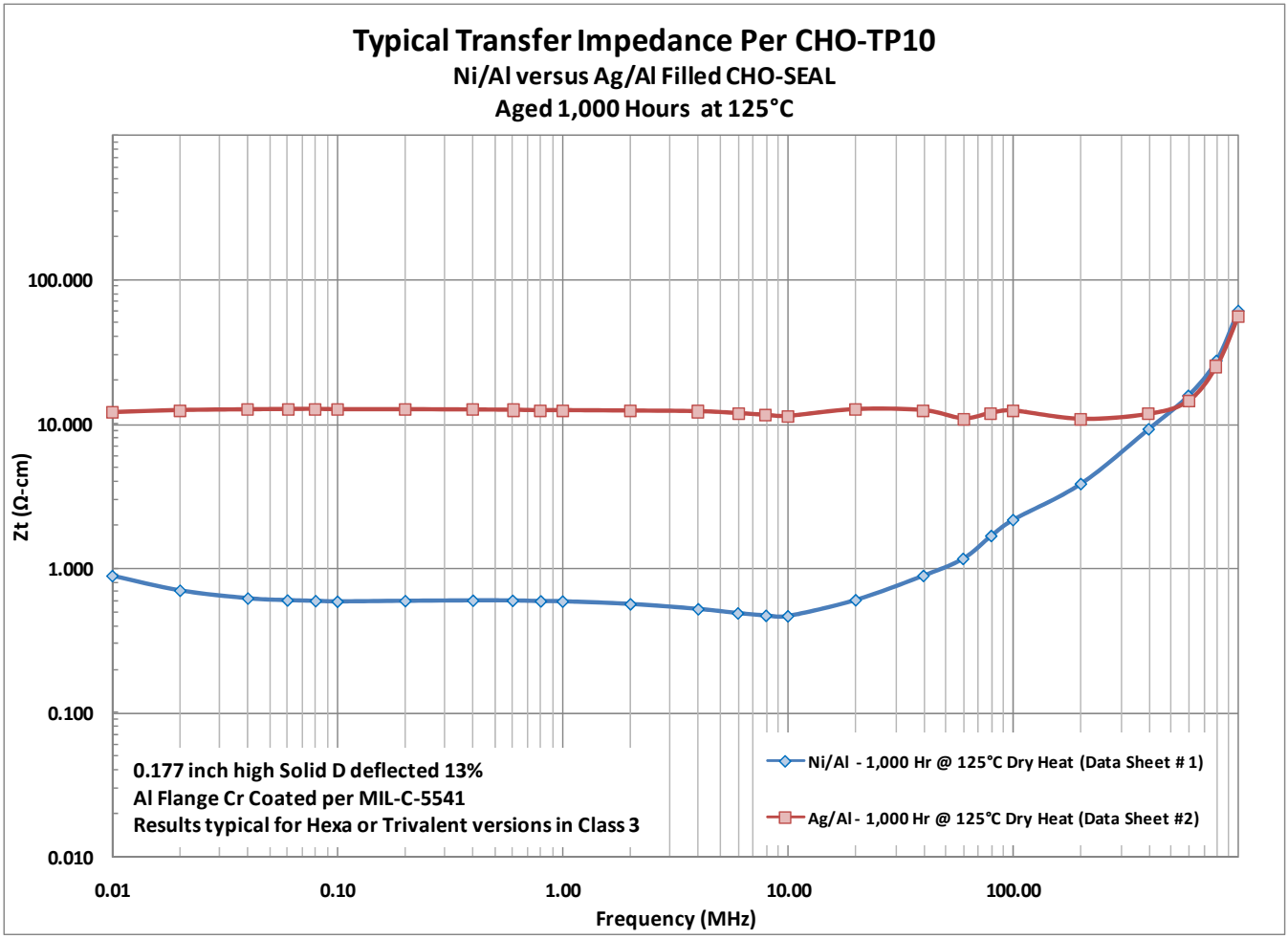

Figure 11: Transfer Impedance Comparison: Ni/Al vs. Ag/Al - 1,000 Hours @ 125°C Dry Heat

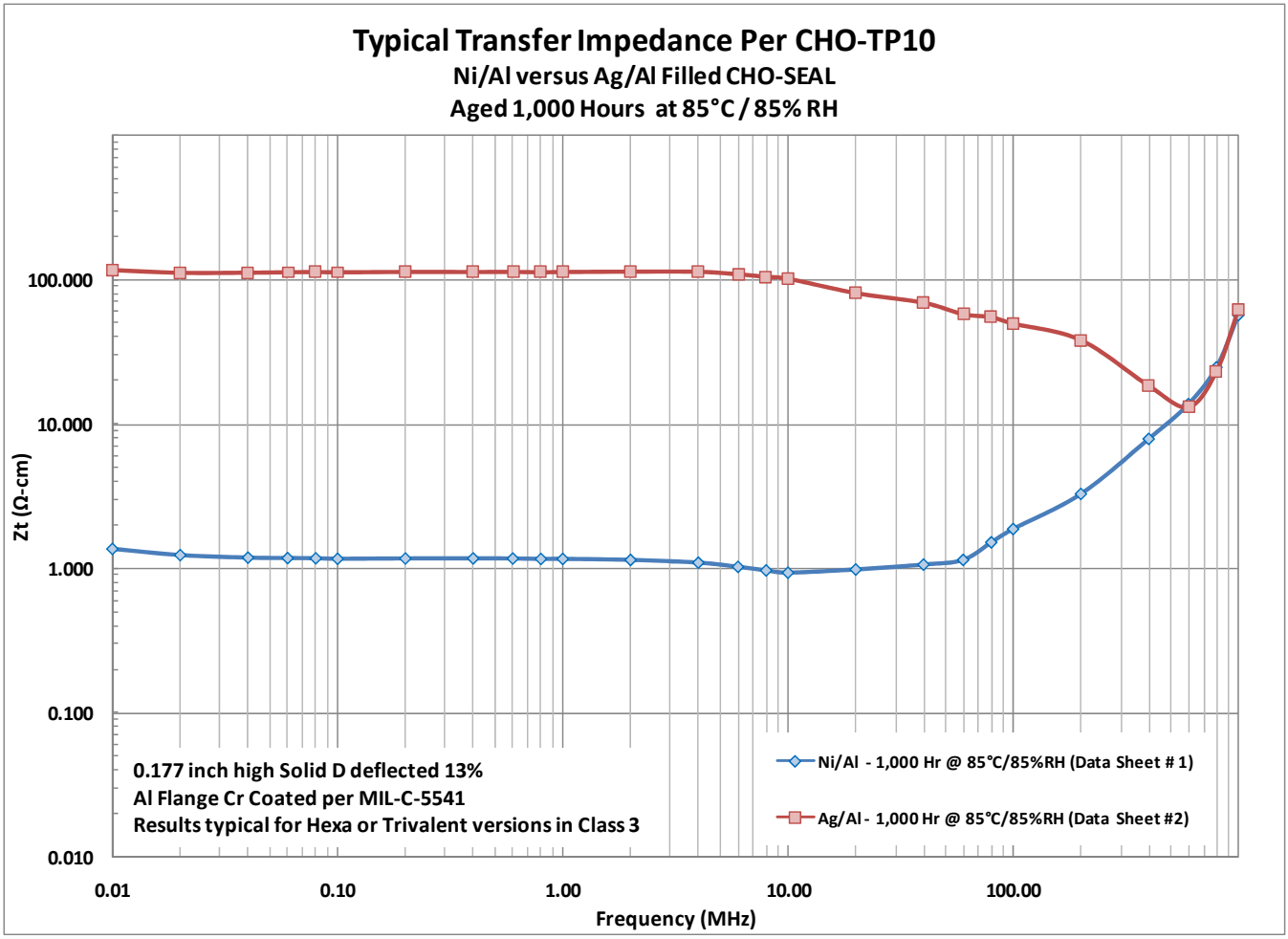

Figure 12: Transfer Impedance Comparison: Ni/Al vs. Ag/Al - 1,000 Hours @ 85°C & 85% RH

5.4 Conclusions

The test data included within this report illustrates that CHO-SEAL Ni/Al filled materials are superior in transfer impedance performance before and after environmental exposure compared to the CHO-SEAL Ag/Al filled equivalent.

As noted in the report, two different types of chromate conversion coatings were evaluated against CHO-SEAL 6502 and CHO-SEAL 1298. The evaluation demonstrated that the transfer impedance was equivalent regardless of chromate flange treatment, elastomer binder or product form. Inclusion of the entire test package within this report was not practical, nor necessary to support this conclusion. The test data sheets and transfer impedance curves shown herein are a composite of results taken over several months of testing on a variety of gasket materials, flange treatments and environmental exposure conditions. Requests for specific test data shall be made through the Parker Chomerics Applications Lab or Test Services.