Parker Chomerics

TEST SERVICES

EVALUATION OF THE
CHO-BOND 1018
CHO-BOND 1019
CONDUCTIVE COMPOUND

Date: JUNE 29, 2023
Test Report Number: SR7562.23

IN ACCORDANCE WITH
IEEE STD 299

Prepared For: SPECIALTY MATERIALS BUSINESS UNIT
PARKER – CHOMERICS
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REVISION RECORD SHEET

Revision	Description	Date	Approval
--	Created Test Report	2023-06-29	

The latest revision of the report is valid, all prior revisions are superseded.

LIST OF DEFINITIONS/ABBREVIATIONS

AC	Alternating Current
BB	Broadband
BW	Bandwidth
cm	Centimeter
CPU	Calibrate Prior to Use
dB	Decibel
DC	Direct Current
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ER	Electric Radiation
EUT	Equipment Under Test
GHz	Gigahertz
Hz	Hertz
I-face	Interface
kHz	Kilohertz
m	Meter
MHz	Megahertz
mm	Millimeter
MR	Magnetic Radiation
mS	Millisecond
MUT	Material(s) Under Test
mV	Millivolt
N/A	Not Applicable or Not Available
NB	Narrowband
NCR	No Calibration Required
PLC	Power Line Conduction
PPS	Pulses Per Second
RF	Radio Frequency
rms	Root mean square
Rx	Receive
SUT	System Under Test
Tx	Transmit
uF	Microfarad
uH	Microhenry
uS	Microsecond
uV	Microvolt
UWC	Use With Calibrated Equipment

1.0 GENERAL

1.1 Introduction

1.1.1 Purpose

The purpose of this test is to evaluate a sequence of electromagnetic shielding tests at the request of Parker-Chomerics Specialty Materials Business Unit. The assessment will determine the shielding effectiveness of the material under test per IEEE-STD-299. The tests were performed by Chomerics Test Services of Woburn, Massachusetts.

This report documents the test results and performance of the Cho-Bond 1018 and Cho-Bond 1019 Conductive Compounds for Shielding Effectiveness Testing per IEEE-STD-299 Standard Method.

Testing was performed from October 14, 2020 through November 2, 2021.

1.1.2 Requirements

No shielding requirements for the material under test are given.

These tests were performed to ascertain the shielding performance.

The tests were performed at Parker Chomerics, Woburn, Massachusetts. The tests satisfy the requirements of IEEE-STD-299.

1.2 Summary

There is no "Pass" or "Fail" criteria. The test data sheets will outline specifically how the test samples performed during each test.

1.2.1 Deviations, Additions, or Exclusions

Tests were performed with no deviations:

1.3 Administrative Data

1.3.1 Test Facility

Chomerics Test Services in Woburn, Massachusetts is an American Association for Laboratory Accreditation (A2LA) accredited facility as defined on Certification Number 1980-01. The Scope of Accreditation can be provided by Chomerics or found on the A2LA Web site at the following location:

http://www.a2la.org/dirsearchnew/newsearch.cfm

All tests included within this report are not covered under Chomerics' A2LA Scope of Accreditation.

Parker Chomerics test facility operates under the current revision of Chomerics Quality Assurance (QA) Manual Document Number QAISO2017.

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 9001, ISO Guide 25, NIST Handbook 150, EN 45001, MIL-STD-461 and Chomerics 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.

1.3.2 Equipment Calibration

The calibration of Parker Chomerics test facility equipment is controlled under the current edition of Chomerics Laboratory Test Equipment List and Calibration Schedule Document Number QA009 and Chomerics Quality Assurance (QA) Manual Document Number QAISO2017.

The test equipment used throughout this test sequence conforms to laboratory calibration standards, ANSI/NCSL Z540-1 and ISO 10012-1, traceable to the National Institute of Standards and Technology (NIST).

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 and ISO 10012-1 at least once per year.

1.3.3 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.).

1.4 Test Set-up

1.4.1 Test Site Descriptions

The following is a list of test sites and descriptions of each.

SE Lab: Chomerics' SE (Shielding Effectiveness) Test Chamber is used for this test program and is located in the Seeger Building at Parker Chomerics, 84 Dragon Court, Woburn, Massachusetts (see Figure 1). The shielded enclosure was manufactured by Sprague Shielding Corporation. Attenuation tests have demonstrated that the shielded enclosure meets the attenuation requirements of MIL-STD-285.

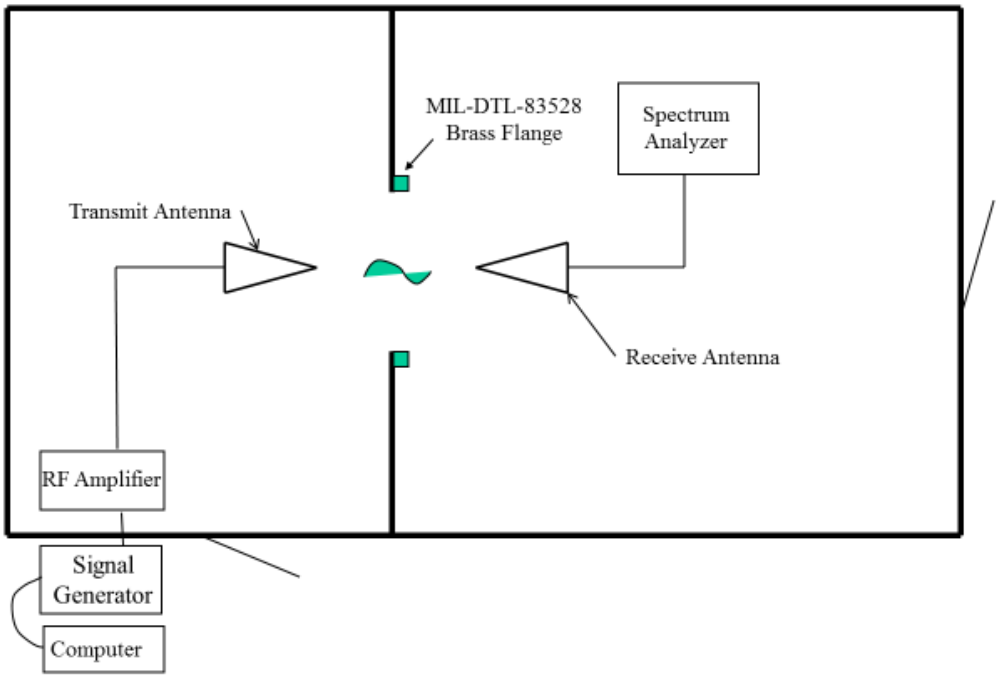
The receive chamber is an 0.635 cm plate steel structure measuring 3.7 x 4.9 x 2.4 meters in size. The structure is heated and/or air conditioned.

The transmit chamber is an 0.635 cm plate steel structure measuring 3.7 x 2.4 x 2.4 meters in size. The structure is heated and/or air conditioned.

When needed for tabletop equipment, a wooden table measuring 0.9 x 2.7 meters in size is positioned within the test chamber.

The available AC power within the shielded enclosure is 110V AC, 220V AC, single and three phase, 60 cycle. The power line filters are rated for 100dB of attenuation from 10kHz to 10GHz.

Figure 1: SE Chamber



1.4.2 Materials Under Test

The descriptions of the Material Under Test (MUT) evaluated are as follows:

1. Cho-Bond 1018
2. Cho-Bond 1019
3. PPG PR 2200

Test Configuration 1: Material applied to a riveted assembly.
Test Configuration 2: Material applied to a slotted panel.

1.5 Applicable Documents

IEEE-STD-299-2006: IEEE Standard Method for Measuring the Effectiveness of Electromagnetic Shielding Enclosures

2.0 TESTS PERFORMED

2.1 Electric Field Shielding Effectiveness (SE)

2.1.1 Equipment Used

	Test Equipment	Asset #	Serial #
X	Agilent 4440A Spectrum Analyzer	704	US41421236
X	HP8341B Synthesized Sweeper	105	2650A00418
X	HP 3326A Signal Generator	37	2519A00753
X	A.R. 30W1000M7 Amplifier	480	15657
X	A.R. 150L Amplifier	888	3747
X	Solar Electronics 6552-1A Audio Amplifier	162	N/A
X	EMCO 3107 Parallel Plate Antenna	86	2146
X	EMCO Passive Rod Antenna	280	9003-2662
X	EMCO 3109 Biconical Antenna	281	2124
X	EMCO 3109 Biconical Antenna	119	8907-2414
X	ETS Lindgren TILE 7.1.2.24	N/A	N/A
X	Dell Computer	N/A	N/A

(See Appendix A for Equipment Calibration)

2.1.2 Test Configurations

The test methods of IEEE-STD-299 were followed. Equipment, such as signal generators and computer system were located outside of the shielded enclosure. The detection system and amplifiers were located inside the shielded enclosure.

Two test configurations were tested:

1. Configuration 1 (Shelter Skin Shielding)
2. Configuration 2 (Shelter Structure Gap)

Each of the above test configurations were tested for each material sample.

2.1.3 Test Fixtures

For Test Configuration 1 (Shelter Skin Shielding), two test plates were used. The Frame is illustrated in Figure 2 and the Cover is illustrated in Figure 3. These test fixtures simulate the Cho-Bond materials used in a caulk/sealant (Fillet) application.

The “Frame” (Figure 2) was fabricated from 6061-T6 aluminum and is 16" x 16" in size and 0.375 inch thick. The Frame has an open aperture 11" x 11" in the center of the plate.

The “Cover” plate (Figure 3) simulates a cover in a typical application. It was fabricated from 6061-T6 aluminum and is 12" x 12" in size and 0.125 inch thick.

The Frame has holes (Thru holes) to accept bolts to the “Cover” and a set of holes at the perimeter to mount it to Parker Chomerics’ shielded enclosure.

These fixtures are assembled together to form a single “Test Set” as illustrated in Figure 4.

Figure 2: Frame Test Fixture

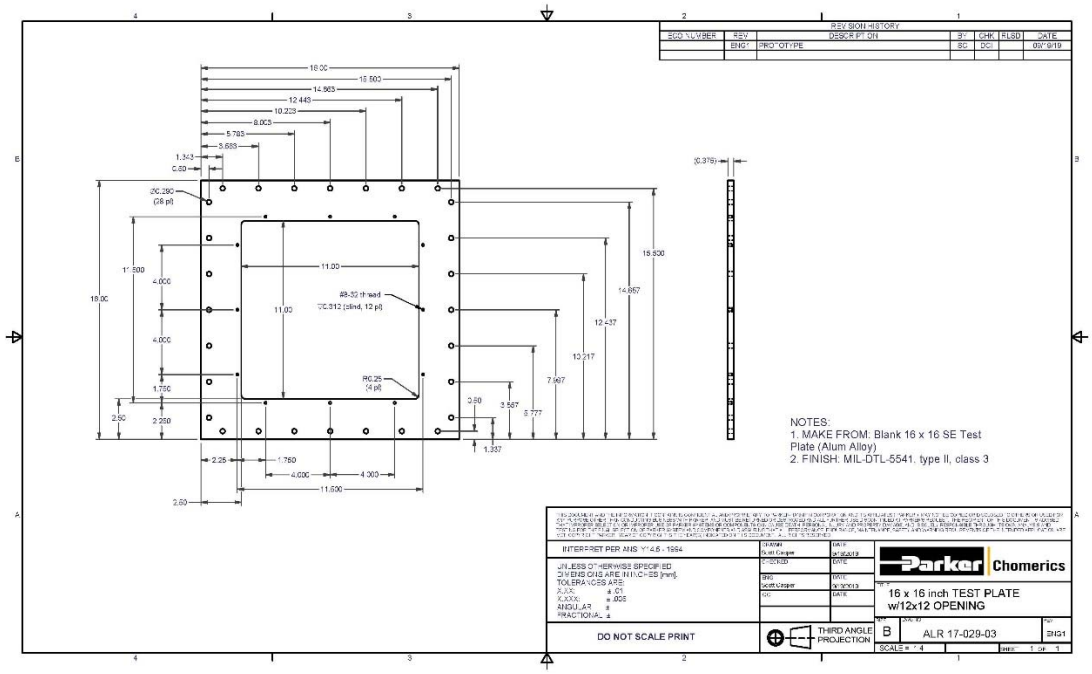


Figure 3: Cover Test Fixture

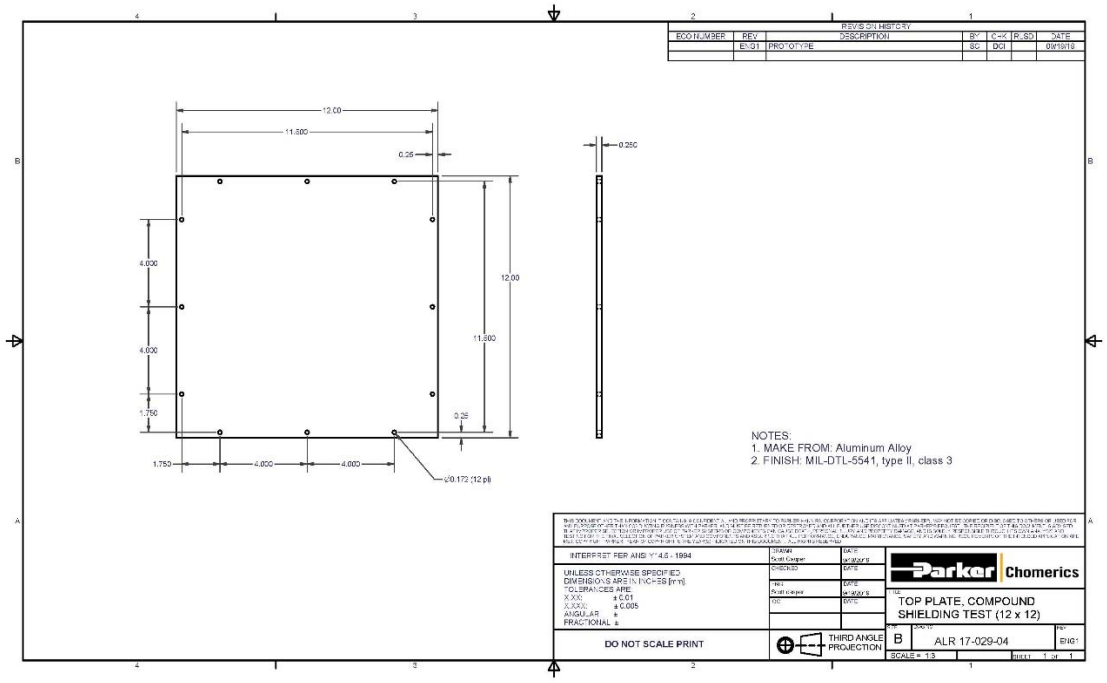
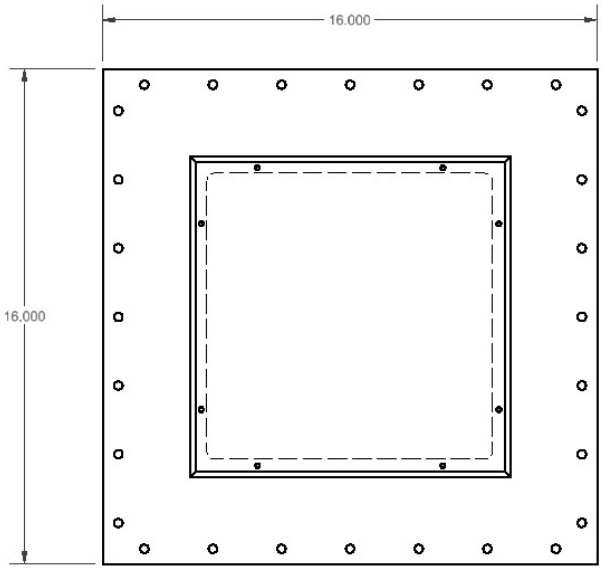


Figure 4: Assembled Test Set



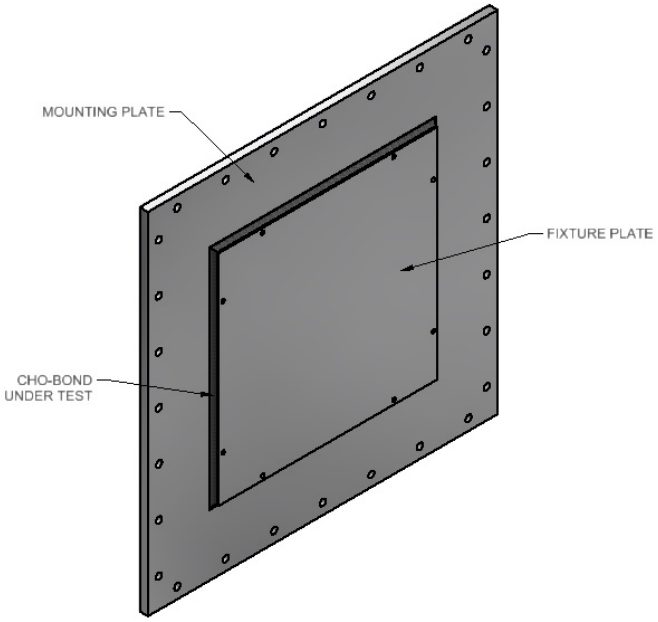
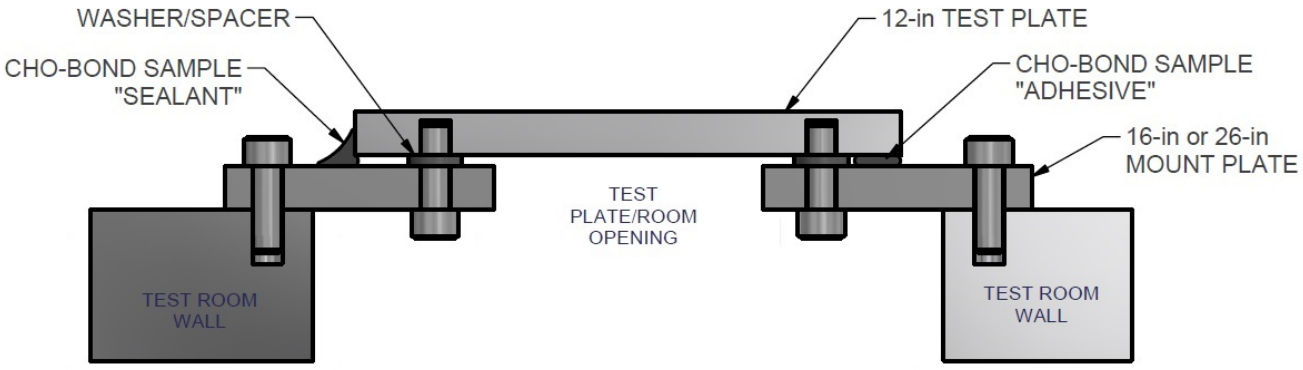


Figure 5 illustrates the location of the compound under test. The left hand side of the figure illustrates the compound applies as a Fillet bridging the gap at the end of the cover plate to the mounting plate. The compound is applied as shown completely around the perimeter of the Cover plate. Plastic washers and bolts were used to fasten the cover to the mounting plate to ensure there was no electrical connection between them other than that provided by the compound under test.

Figure 5: SE Test – Compound Location



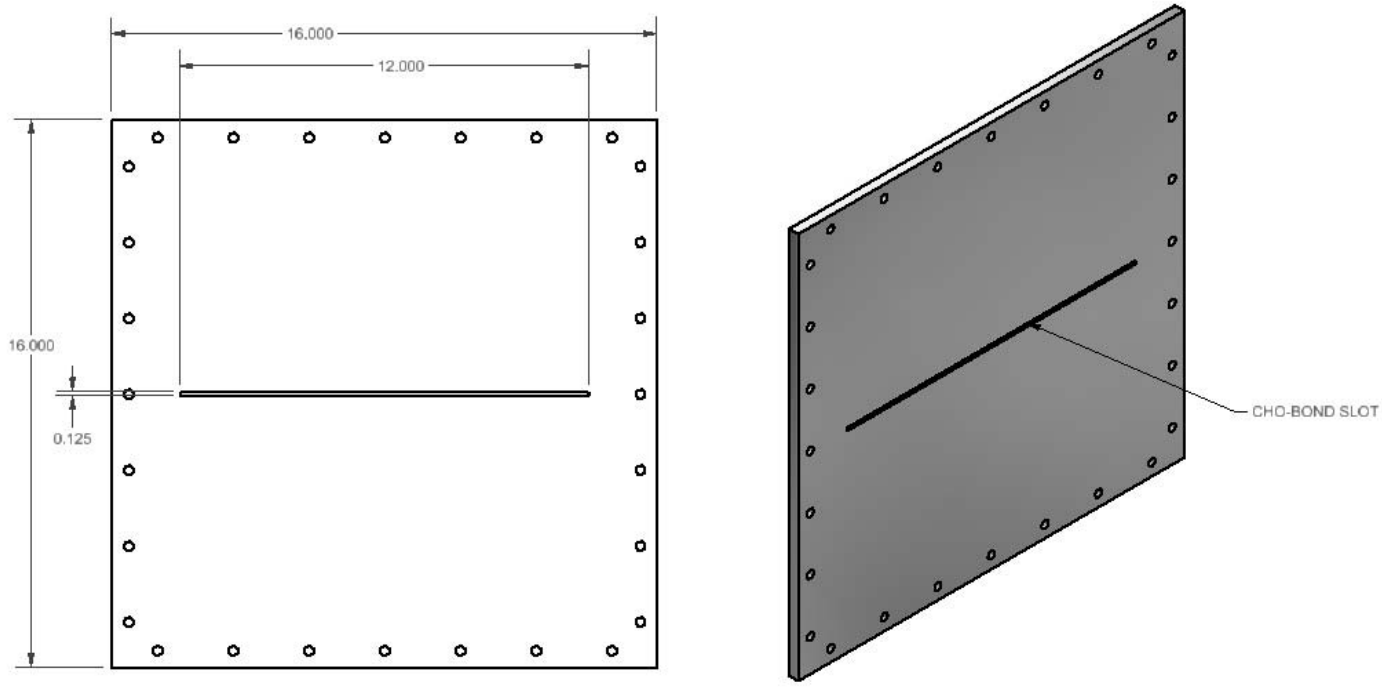
A separate test plate set was assembled for each material under test as defined in Section 2.1.2.

For Test Configuration 2 (Shelter Structure Gap), one test plate was used. The Test Fixture is illustrated in Figure 6.

The test panel was fabricated from 6061-T6 aluminum and was 16" x 16" in size and 0.125 inch thick. There was a 0.125-inch slot across the panel 10 inches long and centered. This was the location of the conductive compound under test. The set of holes at the perimeter was to mount it to Parker Chomerics' shielded enclosure.

The amount of the Conductive Caulks/Sealants and Adhesive materials applied to the test fixtures was recorded by volume or by weight (both if possible).

Figure 6: Slot Test Fixture



2.1.4 Plating and Conversion Coatings

2.1.4.1 Test Fixtures

The test panels were designed and fabricated by Parker Chomerics.

All Test Fixtures were made of 6061-T6 Aluminum and Conversion Coating to MIL-DTL-5541, Trivalent Type II, Class 3

2.1.5 Thermal Shock Testing

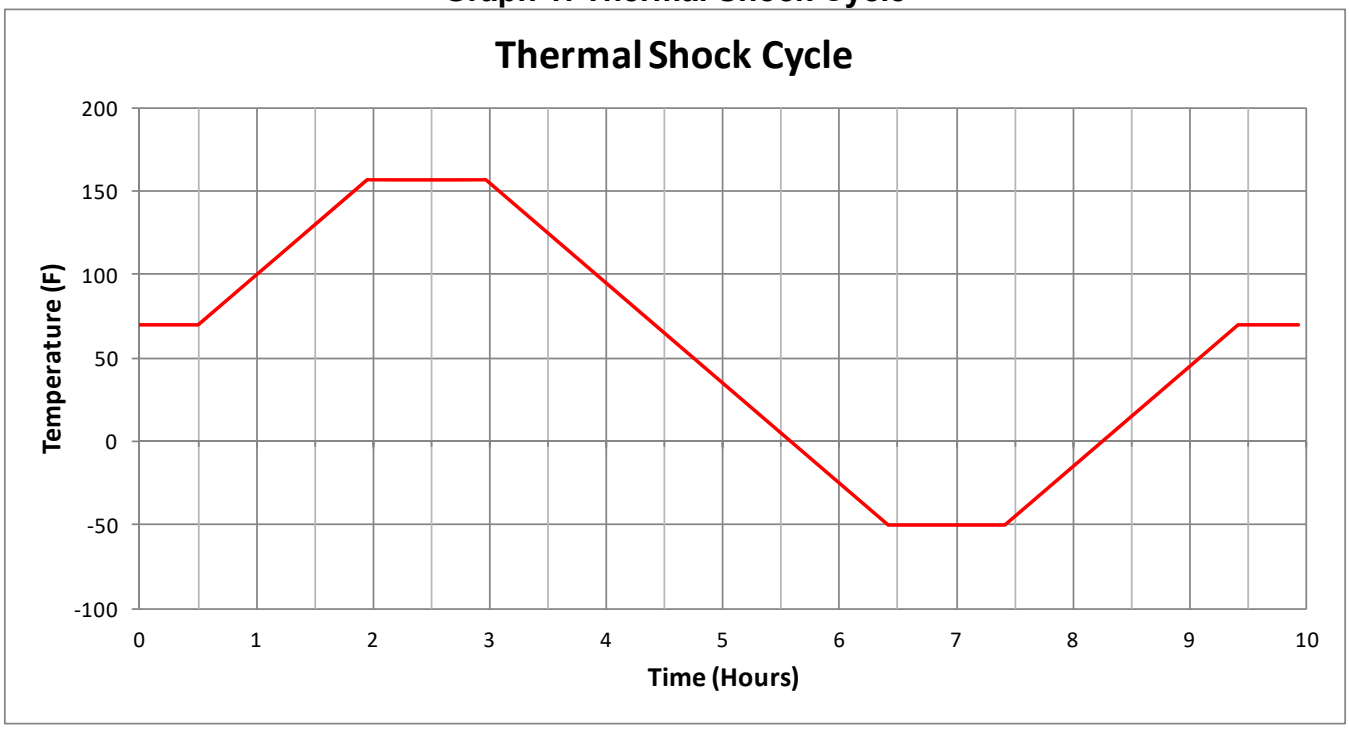
2.1.5.1 Test Method

The Conductive Compound(s) panels were exposed to Thermal shock.

Thermal shock testing was conducted as follows:

1) High Temperature 157° F ±2° F for 1 hour minimum
2) Low Temperature -50° F ±2° F for 1 hour minimum.
3) Start at 70° F for 30 minutes and ramp up and down the high and low temperature setup at a rate of 15° F per 15 minutes. End the cycle at 70° F for 30 minutes.
4) Perform 10 cycles.

Graph 1: Thermal Shock Cycle



2.1.6 Salt Fog Environmental Conditions

All test fixtures were exposed to Salt Fog conditions in accordance with ASTM-B117.

All test fixtures were previously tested for thermal Shock exposure as described in Section 2.1.3.

Plastic was taped to the back side of each shielding effectiveness test panel to ensure that salt water did not pool against the gasket in between the cover and frame and to protect the surface that mates to the shielded enclosure.

The Test Panels were tested in accordance ASTM B117 Salt Fog for a duration of 500 hours. The spray contains a 5% +/- 1% salt solution while samples rest 6° vertical in the environmental chamber. Salt spray application were conducted for a 500-hour duration.

After the 500-hour salt fog exposure, final Shielding Effectiveness testing was completed.

2.1.7 Shielding Effectiveness Testing

Shielding Effectiveness testing was performed initially after assembly of the test panels.

A final shielding effectiveness test was performed after both thermal shock and salt fog exposure.

2.1.7.1 Test Methods

The shielded effectiveness test was performed in Parker Chomerics SE Lab as illustrated in Figure 1. The Test Panels were tested to the requirements of this section.

One “worst case” antenna polarization was used. Initial baseline SE tests were done in both horizontal and vertical antenna polarizations to determine which polarization was worst case. After determination of which polarization was worst case, only this worst case antenna polarization was required during follow on testing. Receive and Transmit antenna polarizations were matched.

Antenna polarization was the same for both Open Reference measurements and final shielding effectiveness measurements. The transmit and receive antenna polarizations were identical. The transmitting and receiving antennas were directed at each other, the distance between antennas, measured from antenna tip to antenna tip, was 5 feet (+/- 2.0 inches) if possible.

The antennas and frequency ranges were as follows:

Table 1: Shielding Effectiveness Test Antennas

Test Frequency Range	Transmit Antenna	Receive Antenna
250MHz to 1GHz	EMCO 3106 Dual Ridge Guide	EMCO 3106 Dual Ridge Guide
1GHz to 18GHz	EMCO 3115 Horn Antenna	EMCO 3115 Horn Antenna
18GHz to 26GHz	Eaton 94626 Horn Antenna	Eaton 94626 Horn Antenna
26GHz to 40GHz	Eaton 94627 Horn Antenna	Eaton 94627 Horn Antenna

The instrumentation was stepped through the test frequencies, and the received signal strength for each test frequency and antenna polarization was recorded as the non-linear signal (dB) for that test area (or test point) and configuration.

The transmit signal was controlled through automation using ETS-Lindgren TILE software. Measurements were recorded manually. Frequency stepping was interrupted as necessary to perform antenna/amplifier/signal generation changes.

For each test area or test point shielding effectiveness measurements were made at the following test frequencies:

- 250, 300, 400, 500, 600, 700, 800, 900, 1000 MHz for electric field shielding effectiveness measurements
- 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34 ,36, 38 and 40 GHz for plane wave shielding effectiveness measurements

The shielding effectiveness was calculated by taking the power level recorded during the open reference measurement and subtracting it from the power level recorded from the final SE measurement. Below is a sample calculation.

Shielding Effectiveness = Open Reference Level – Final Measurement

= +10dBm – (-120dBm)
= 130dB

Identical antennas, equipment, cables and equipment settings (except internal attenuator settings) were used in the reference and measurement setups.

The reference level data for each test frequency was compared with the noise floor in the test chamber for the frequency under test and the dynamic range was determined by subtracting the noise floor from the reference level and recorded.

Parker Chomerics conducted “thru-hole” open reference measurements with only the frame mounted to the aperture. This procedure was conducted in the SE chamber. The transmit and receive antennas were directed at each other through the open aperture, the distance between antennas, measured from antenna tip to antenna tip, was 5 feet (+/- 2.0 inches) if possible. The transmit antenna in the transmit room was placed 1-foot from the thru-hole opening and the receive antenna in the receive room was placed 4 feet from the thru-hole opening. The thru-hole Reference measurement test setup is illustrated in Figure 7.

In addition, “Free Space” Open Reference Measurements for all test frequencies and polarizations was performed per Figure 3(a) and 3(b) of IEEE-STD 299-1997. This procedure was conducted outside the SE chamber. The transmit and receive antennas spacing and arrangement for free space open reference were identical to the thru-hole open reference procedure stated above. The Free Space Open Reference measurement test setup is illustrated in Figure 8. Free Space Open Reference Measurements can be conducted at any time.

Reference measurements were recorded for both “Thru-Hole” and “Free Space” reference measurements.

Figure 7: Thru Hole Open Reference Measurements

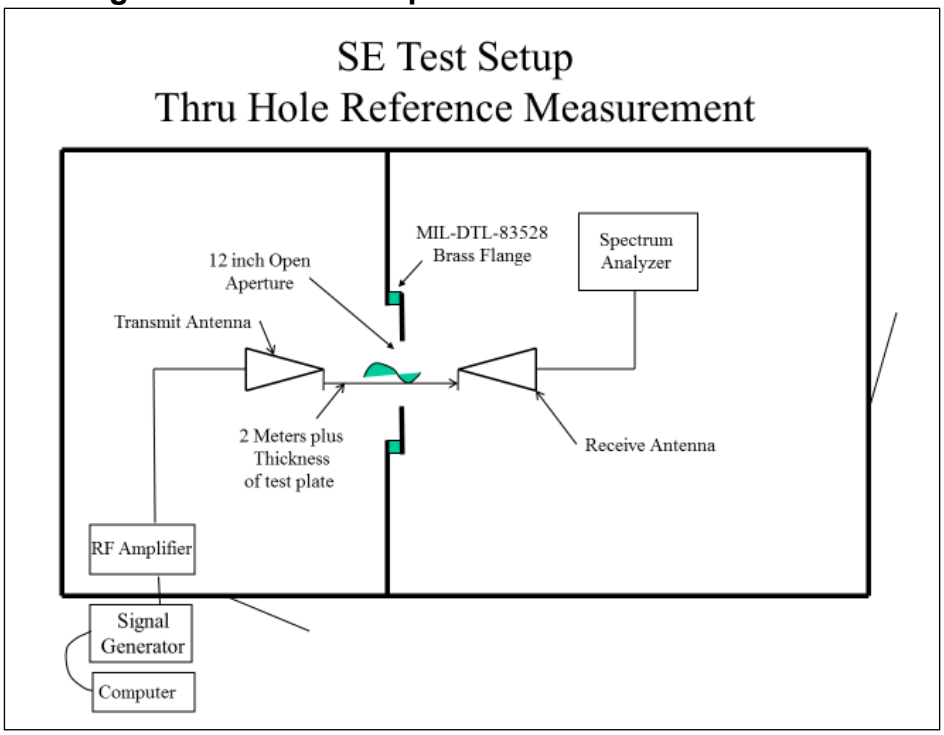
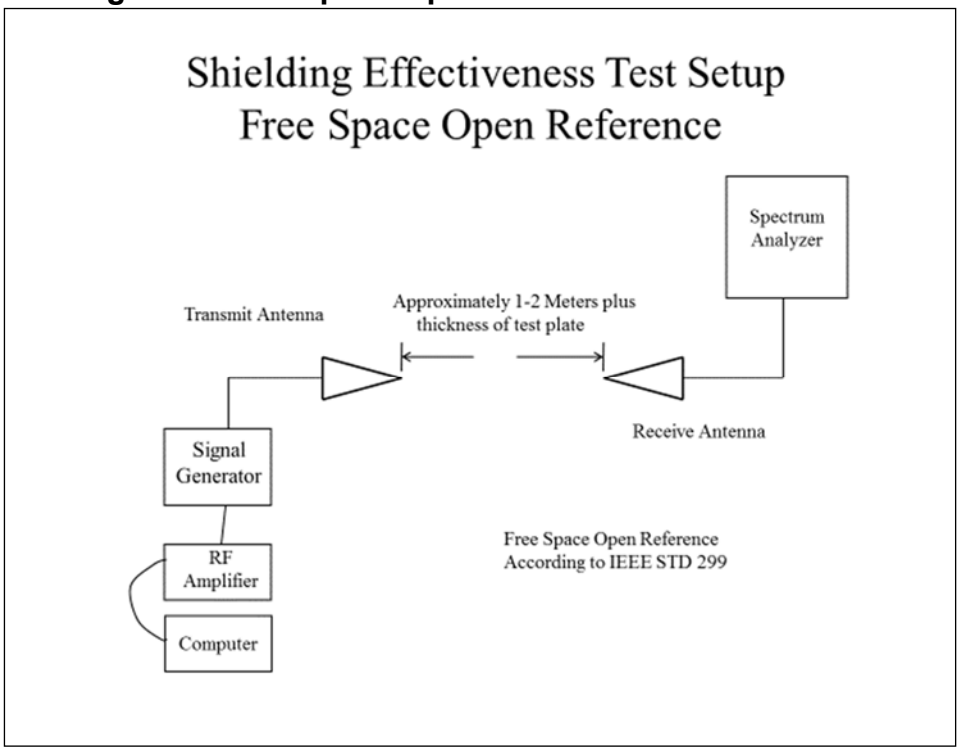


Figure 8: Free Space Open Reference Measurements



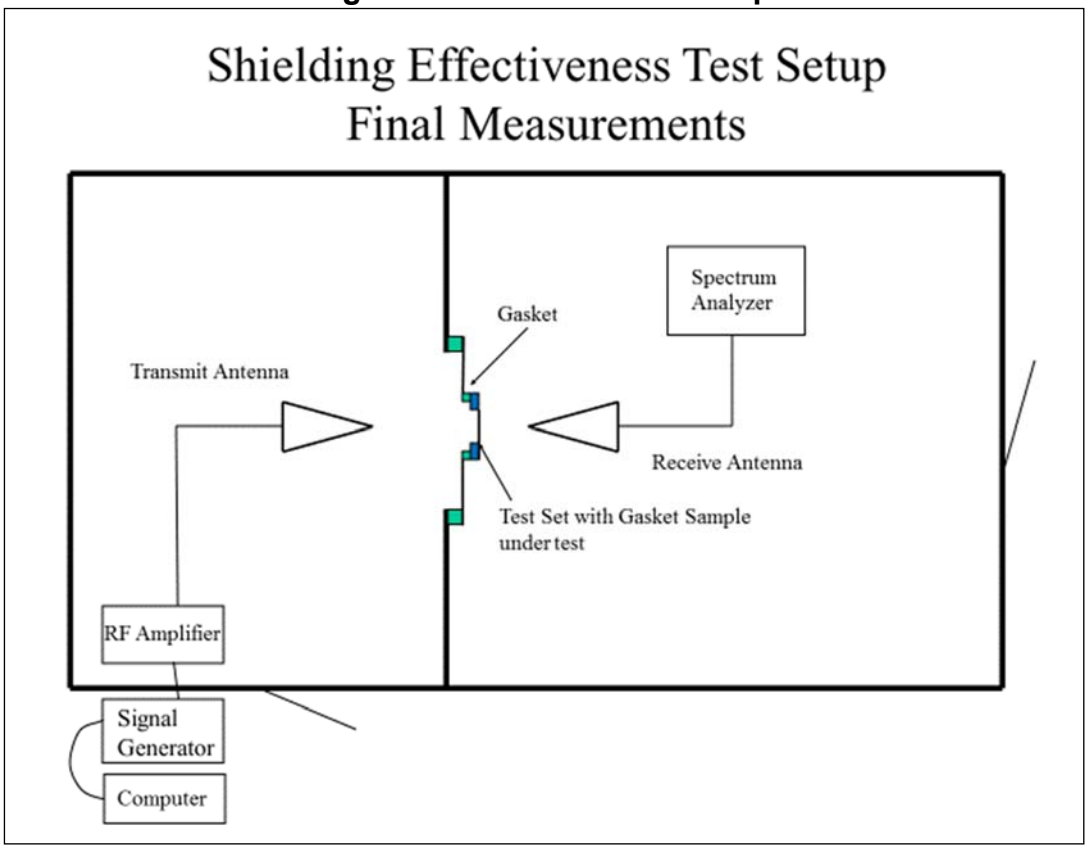
Panels were marked with the orientation of how they were mounted on the wall so the same position was used throughout the test.

The Test Panel frame surface was cleaned for mounting onto the test chamber wall. This required removal of any chromate finish, contaminates, or corrosion from the Test Panel surface that mates to the chamber wall. Copper tape was applied around the perimeter of the test fixture (if deemed necessary) as an additional measure to remove the effects of mounting the frame to the test chamber.

Shielding effectiveness measurements for each Test Panel at each test frequency and required antenna polarization were performed as shown in Figure 4(a) and 4(b) of IEEE-STD 299-2006.

The transmit and receive antennas spacing and arrangement in the SE chamber were identical to the thru-hole reference procedure. The final Shielding Effectiveness measurement test set up was illustrated in Figure 9.

Figure 9: Measurement Set-up



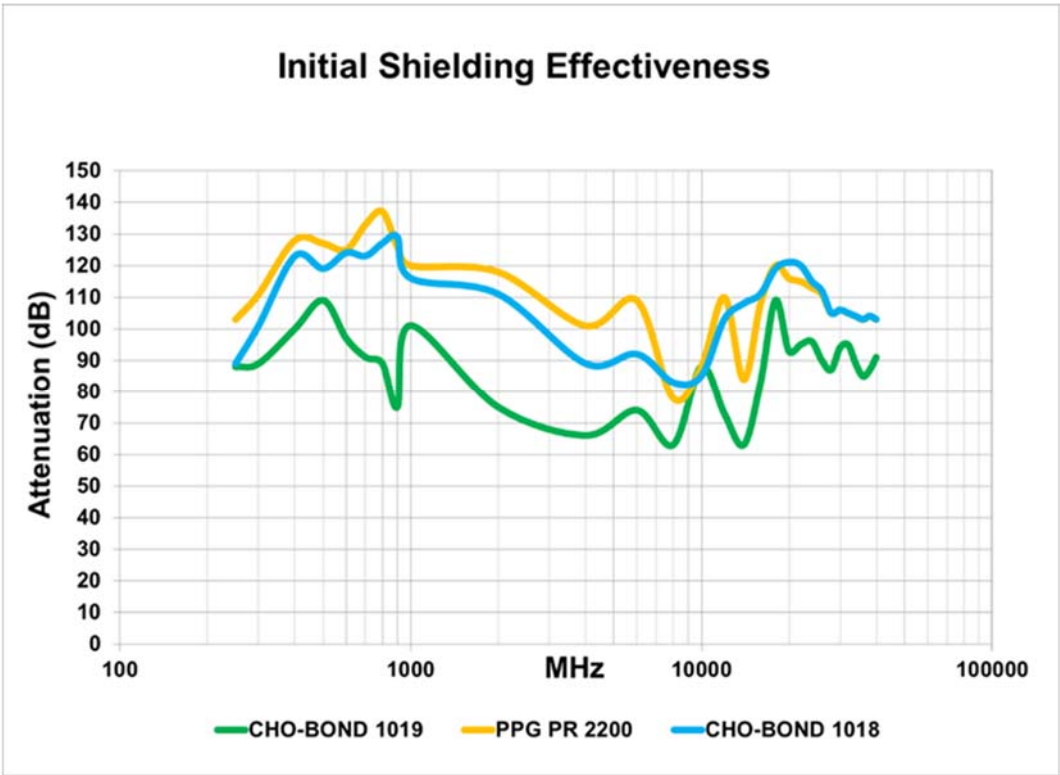
2.1.8 Results

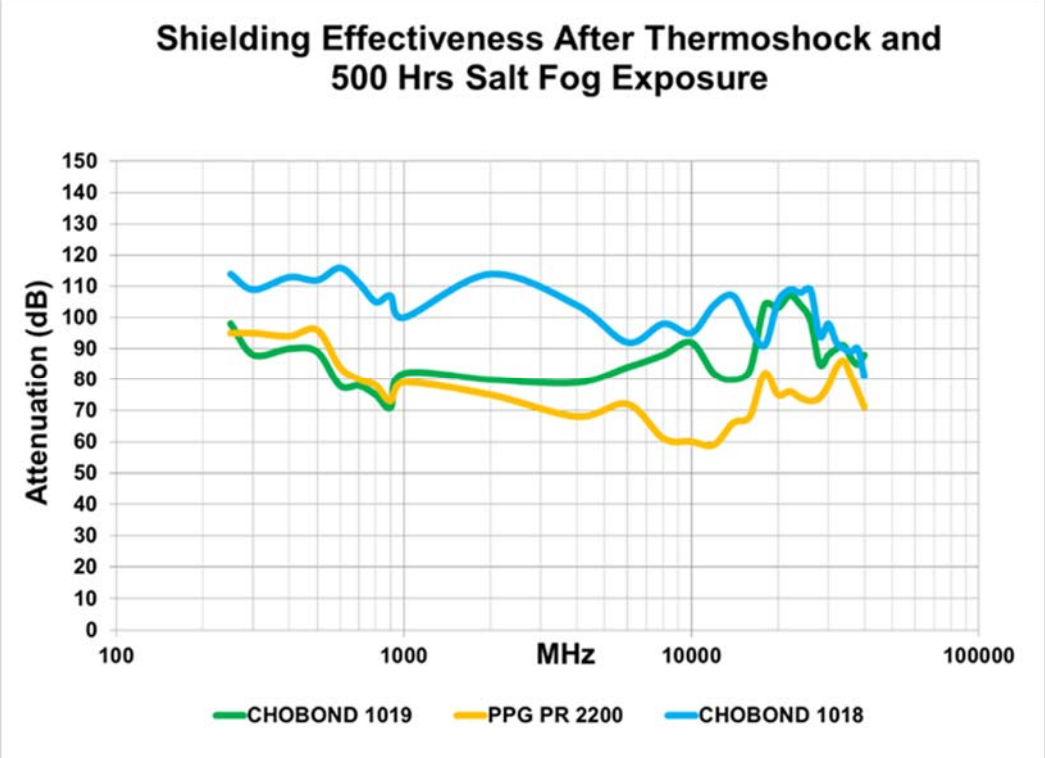
Data sheets and graphs (in the section that follows) display shielding performance with respect to open reference measurement techniques conducted in “free space”. Due to the number of data sheets and measurements, not all test data was graphed. Data tables that follow display shielding performance with respect to open reference measurement techniques conducted in free space and conducted thru-the-hole 124 inch aperture or slot).

The graphs that follow show the EMI shielding performance of these three electrically conductive polythioether compounds before and after environmental exposure. The Initial EMI shielding graph shows slightly better EMI shielding performance from the nickel containing compounds, CHO-BOND 1018 (Ni/C filled) and PPG’s PR 2200 (Ni filled) which is not unexpected given nickel’s ferromagnetic nature and hardness.

Following Thermoshock and 500 hours Salt Fog exposure, both CHO-BOND 1019 and CHO-BOND 1018 show superior EMI shielding performance as compared to PPG’s PR 2200. The EMI shielding stability of CHO-BOND 1019 and CHO-BOND 1018 in harsh environments can be attributed to their corrosion resistant fillers which minimize galvanic corrosion between these electrically conductive sealants and aluminum substrates. Both CHO-BOND 1018 and CHO-BOND 1019 show greater than 80 dB shielding after Thermoshock and 500 hours Salt fog exposure over the 1GHz to 40GHz frequency range.

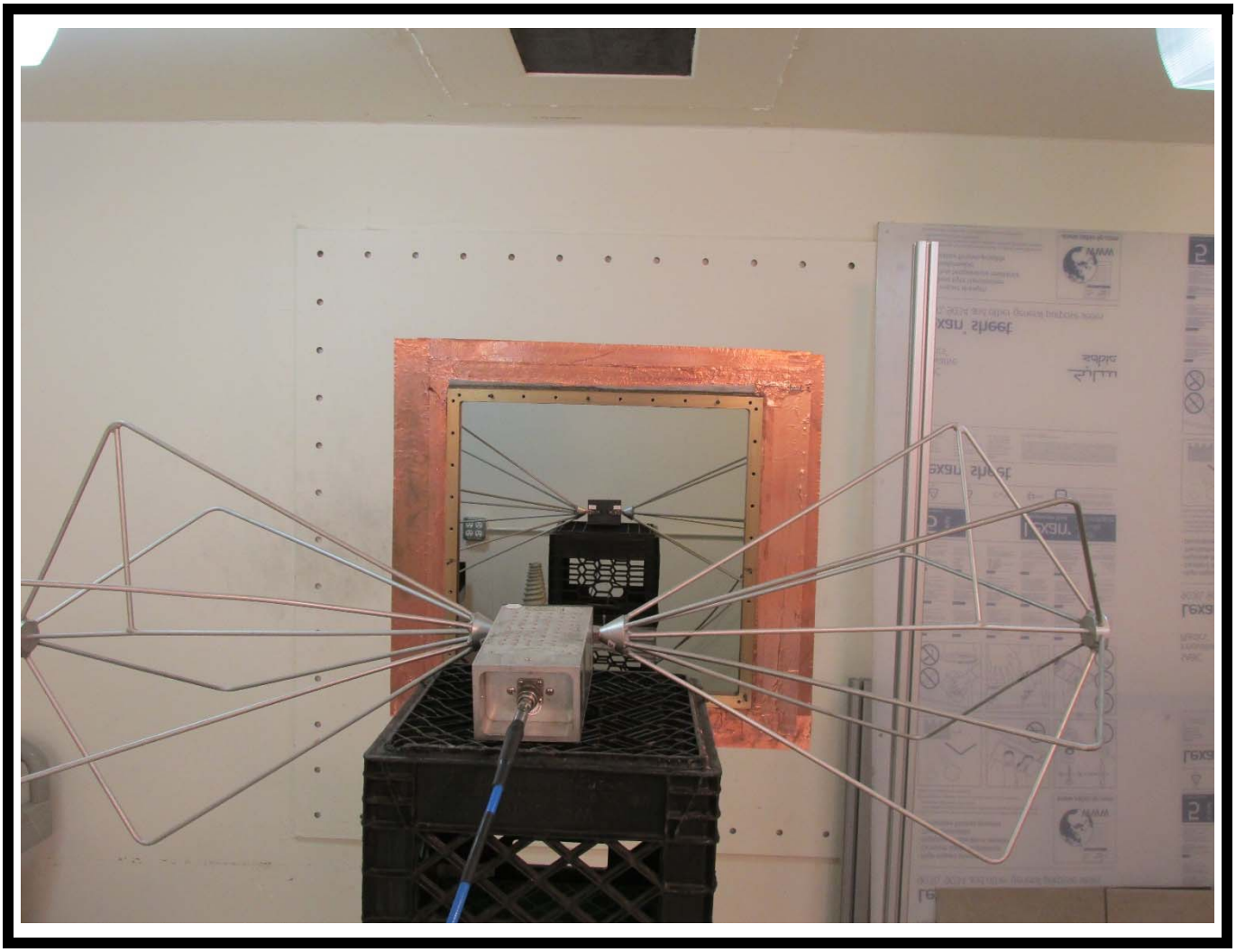
3.0 Test Data


Initial Shielding Effectiveness
Attenuation (dB)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
100
1000
MHz
10000
100000
CHO-BOND 1019
PPG PR 2200
CHO-BOND 1018


Shielding Effectiveness After Thermoshock and 500 Hrs Salt Fog Exposure
Attenuation (dB)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
100
1000
MHz
10000
100000
CHOBOND 1019
PPG PR 2200
CHOBOND 1018

4.0 Photographic Documentation

Customer: Specialty Materials
Equipment: Cho-Bond 1018/1019 Conductive Compound
Tested By: Dung Pham/Nick Orphanos **Coupling Device: Antennas**
Operating Mode: Configuration 2 **Test Spec: IEEE-STD-299**



Photograph Description: Receive Chamber. Thru hole Open Reference 20MHz to 300MHz

FORM CTS-PHOTO

Photographic Documentation

Customer: Specialty Materials
Equipment: Cho-Bond 1018/1019 Conductive Compound
Tested By: Dung Pham/Nick Orphanos
Operating Mode: Configuration 1
Coupling Device: Antennas
Test Spec: IEEE-STD-299

Photograph Description: Transmit Chamber

FORM CTS-PHOTO

Photographic Documentation

Customer: Specialty Materials
Equipment: Cho-Bond 1018/1019 Conductive Compound
Tested By: Dung Pham/Nick Orphanos
Operating Mode: Configuration 2
Coupling Device: Antennas
Test Spec: IEEE-STD-299

Photograph Description: Receive Chamber. Closed Test . 20MHz to 300MHz

FORM CTS-PHOTO

Photographic Documentation

Customer: Specialty Materials
Equipment: Cho-Bond 1018/1019 Conductive Compound
Tested By: Dung Pham/Nick Orphanos **Coupling Device: Antennas**
Configuration 1 **Test Spec: IEEE-STD-299**

Photograph Description: Receive Chamber. Assembly mounted to frame.

FORM CTS-PHOTO

Photographic Documentation

Customer: Specialty Materials
Equipment: Cho-Bond 1018/1019 Conductive Compound
Tested By: Dung Pham/Nick Orphanos

Coupling Device: Antennas
Test Spec: IEEE-STD-299

Photograph Description: Receive Chamber Test Equipment.

FORM CTS-PHOTO

Photographic Documentation

Customer: Specialty Materials
Equipment: Cho-Bond 1018/1019 Conductive Compound
Tested By: Dung Pham/Nick Orphanos

Coupling Device: Antennas
Test Spec: IEEE-STD-299

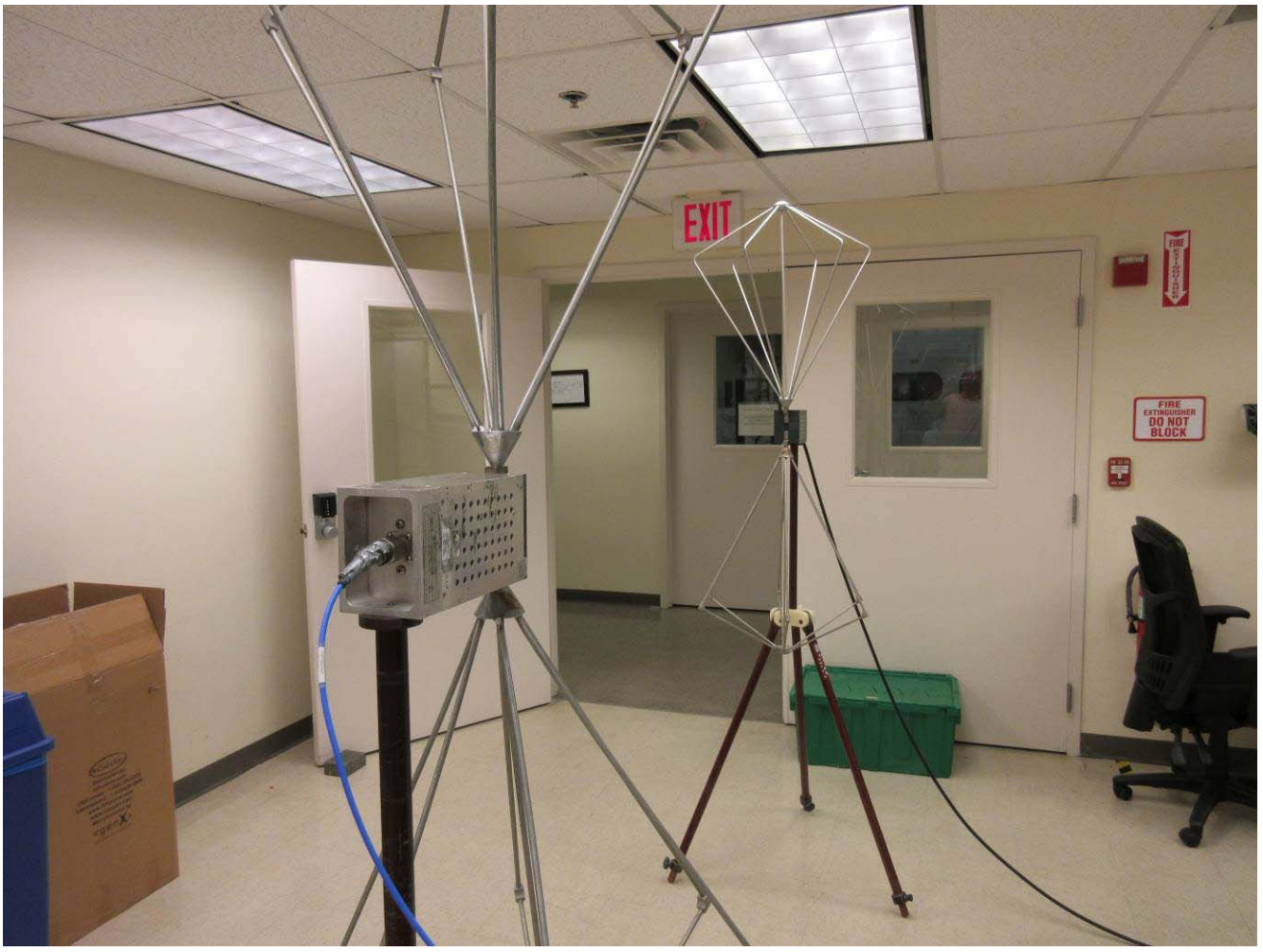
Photograph Description: Free Space Open Reference Setup (1kHz to 10MHz).

FORM CTS-PHOTO

Photographic Documentation

Customer: Specialty Materials
Equipment: Cho-Bond 1018/1019 Conductive Compound
Tested By: Dung Pham/Nick Orphanos

Coupling Device: Antennas
Test Spec: IEEE-STD-299



Photograph Description: Free Space Open Reference Setup (20MHz to 300MHz).

FORM CTS-PHOTO

APPENDIX A: EQUIPMENT CALIBRATION

Test Equipment	Asset #	Serial #	Last Cal Date
50Ω Coaxial Cables	N/A	N/A	NCR
50uH Inductor	N/A	N/A	NCR
Advantest R3261C Spectrum Analyzer 9kHz-26GHz	1100	71720205	2022/10
AE Techron 7224 Audio Amplifier	Rental	0813-0655	NCR
Agilent E8257D-520 Signal Generator	Rental	MY46130758	2022/08
Agilent E8257D-540 Signal Generator	Rental	MY46521831	2023/05
Agilent E4440A Spectrum Analyzer	704	US41421236	2023/02
Agilent 33210A Arbitrary Waveform Generator	909	MY48005722	NCR
Agilent E4401B Spectrum Analyzer	725	MY44140273	2023/03
Agilent 33210A Arbitrary Waveform Generator	919	MY48005727	2022/09
Agilent 33522A Arbitrary Waveform Generator	952	MY50003045	2022/10
Agilent 6653A DC Power Supply	925	MY400030002	NCR
Agilent/HP 8447D Pre Amp	887	2443A04253	NCR
Agilent/HP 8447D Pre Amp	12	2944A06414	NCR
Agilent/HP 8341B Synthesized Sweeper	105	2650A00418	UWC
Agilent/HP Power Meter 437B	203	2949A02617	2023/04
Agilent/HP Power Sensor 8481A	1069	2237A34135	2023/04
Agilent/HP 651B Signal Generator	57	1230A10422	2022/09
Agilent/HP 3325A Signal Generator	617	2512A28039	NCR
Agilent/HP 8753E Network Analyzer	738	US38432018	2022/05
Agilent/HP 974A True RMS Voltmeter	642	JP40008954	2023/05
Agilent/HP 974A True RMS Voltmeter	632	JP40009239	2022/06
Agilent/HP 3326A Signal A Signal Generator	37	2519A00753	NCR
Agilent/HP 83620B Signal Generator	624	3844A00963	NCR
Agilent/HP 83620B Signal Generator	625	3844A00955	NCR
Agilent/HP 11867A RF Limiter	N/A	05002	NCR
Agilent/HP 11867A RF Limiter	N/A	MY4224-1318	NCR
Agilent/HP 5340A Frequency Counter	139	2148A08245	UWC
Agilent/HP 8474B GaAs Microwave Diode Detector	610	01656	UWC
Agilent/HP N9355B RF Limiter	N/A	MY45450141	NCR
Agilent/HP N9355B RF Limiter	N/A	MY45450142	NCR
Agilent/HP N9355B RF Limiter	N/A	MY45450146	NCR
Agilent/HP 83640A Signal Generator	38	3009A00188	NCR
AH Systems Horn Antenna SAS-587 18-26.5GHz	1097	199	2023/05
AH Systems Horn Antenna SAS-588 26.5-40GHz	1092	184	2023/05
AH Systems SAS-550-2B Vertical Rod Antenna	897	283	2023/03
AH Systems ECF-10 Calibration Fixture	918	190	2023/03
AH Systems 12” Passive Loop Antenna SAS-563P	1032	554	NCR

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Alpha 861W-387 75 to 110GHz Horn Antenna	1004	484	NCR
Alpha W861 75 to 110GHz Horn Antenna	1003	108	NCR
AlphaLab Model USSVM2 DC Voltmeter	1047	184	2022/09
AlphaLab Model UHS2 AC Milligauss Meter	1068	542	2022/10
Amprobe LH41A	1084	19060094	2022/11
Amprobe MO-100 Milliohm meter	1015	15030185	2023/05
AR Model DC2035A Dual Directional Coupler	854	306152	2022/10
AR 2500LMS 2.5kW Amplifier 10kHz - 220MHz	853	325925	NCR
AR 100W1000B 100 Watt Amplifier	768	311120	NCR
AR 30W1000M7 Amplifier	480	15657	NCR
AR 100W1000M7 Amplifier	884	9568	NCR
AR 1000W1000M7 80-1000MHz Amplifier	818	323326	NCR
AR 250T1G3 1-2.5GHz Amplifier	784	313235	NCR
AR 300T2G8 2.5-7.5GHz Amplifier	785	313230	NCR
AR 250T8G18 7.5-18GHz Amplifier	786	313234	NCR
AR FM2000 Field Monitor	39	13009	UWC
AR FP2000 Isotropic Field Probe	40	12914	2022/09
AR FP2080 Isotropic Field Probe	767	309531	2022/09
AR 888 Leveling Preamplifier	491	15606	UWC
AR AT5000M1 Billboard Antenna	856	0325328	NCR
AR Model 150L Amplifier	888	9747	NCR
Belden RG2140 100’ cable	567	N/A	2023/02
Bird 8130 50 watt Coaxial Load Resistor	220	3387	2023/05
Bird 8129 2000 watt Coaxial Load Resistor	419	2176	NCR
Bird 8125 300 watt Coaxial Load Resistor	292	3939	2023/05
Bird 9825 10 watt	585	N/A	2023/05
Bird 9919 10watt	594	N/A	2023/05
Bird 10-18T-MN	971	N/A	2023/05
BK Precision 890C Capacitance Meter	965	128B12223	2022/08
Boonton 4232A RF Power Meter	777	148602	2022/09
Boonton 51011 EMC RF Power Sensor	983	34700	2022/09
BSWA Microphone Model SM4201	896	460225-440127	NCR
Chomerics 1 GHz to 18 GHz L.N.A. System	840	N/A	2022/06
Chomerics 1 GHz to 18 GHz L.N.A. System with 45dB Miteq	984	N/A	2022/06
Chomerics Closed Circuit CCD monitor	N/A	N/A	NCR
Chomerics Closed Circuit Color monitor	N/A	N/A	NCR
Chomerics 100 Ohm Resistor	N/A	N/A	NCR

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Chomerics Helmholtz Coil A	441	N/A	UWC
Chomerics Helmholtz Coil B	442	N/A	UWC
Chomerics Coil C (1m x 1m)	812	N/A	UWC
Chomerics Coil D (1m x 2.6m)	962	N/A	UWC
Chomerics Spiral Loop Antenna	N/A	N/A	NCR
Chomerics CS115 SucoFlex 406D Injection cable	977	0220	NCR
Chomerics Power Transformer	1073	N/A	NCR
Chomerics Power Transformer	1074	N/A	NCR
Chomerics Artificial Hand	N/A	N/A	NCR
Chomerics 100kHz -200MHz Amplifier	1086	N/A	NCR
Chomerics 12” Magnetic Loop Antenna	112	N/A	NCR
Chomerics 12” Magnetic Loop Antenna	113	N/A	NCR
Chomerics Amplifier 6GHz to 18GHz	1098	N/A	NCR
Chomerics Amplifier 600MHz to 6GHz	1099	N/A	NCR
Cincinnati Sub-Zero Temperature/Humidity Chamber ZH-32-2-H/AC	544	Z09712530	2023/03
Com-Power LI-325 LISN	963	201616	2022/09
Com-Power LI-325 LISN	964	201615	2022/09
Com-Power LPA ALP-100	1032	351240	2023/03
Com-Power LPA ALP-100	1112	10170024	2022/05
Dale 0.5Ω Resistor	1030	N/A	2022/10
Dell Laptop (running Excel)	N/A	N/A	NCR
Dell Computer System (Desktop and Flat Panel Monitor)	N/A	N/A	NCR
Dwyer Mercoid Mercury Wetted Relays Model 9-51SA	N/A	N/A	NCR
Eaton 94626-1 (26.5G) Antenna	249	146	NCR
Eaton 94627-1 26.5-40GHz Antenna	335	137	NCR
Eaton 94626-1 18-26.5GHz Antenna	334	145	NCR
Eaton 94627-1 26.5-40GHz Antenna	333	136	NCR
Eaton Bulk Current Injection Probe 95242-1	215	290	NCR
Eaton Probe Calibration Fixture 95241-1	219	0179680-04	UWC
Eaton Current Probe 91550-1	218	2759	2023/03
Eaton Current Probe 954111-1	217	1393	2023/03
Eaton 91888-2 1-2.5GHz Antenna	401	529	NCR
Eaton Horn Antenna Mounting Adapter Handle	399	54478-104	NCR
Electro-Metrics EM-2107 ASTM D4935 Fixture	722	105	UWC
Elgar Programmable Power Source SW5250A	N/A	0445A00489	UWC
Elgar Smartwave Control Suite v3.00.02	N/A	N/A	NCR
Elgar SW 5250M	870	0841A00418	UWC

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Elgar SW 5250S	871	0841A00419	UWC
Elgar SW PDU	868	0839A0329	UWC
EMCO 3301B Vertical Rod Antenna	371	2901	2023/02
EMCO 3109 Biconical Antenna	87	2123	2022/05
EMCO 3109 Biconical Antenna	116	2415	2023/03
EMCO 3109 Biconical Antenna	119	2414	2023/03
EMCO 3109 Biconical Antenna	281	2124	2023/02
EMCO 3115 Double Ridge Guide Antenna	282	2345	NCR
EMCO 3106 Ridge Guide Horn Antenna	117	2213	2023/03
EMCO 3106 Ridge Guide Horn Antenna	120	2212	2023/03
EMCO 3115 Ridge Guide Horn Antenna	376	2796	2023/03
EMCO 3115 Ridge Guide Horn Antenna	374	2174	2023/02
EMCO 3115 Double Ridge Guide Antenna	375	2175	2023/02
EMCO 3303 Passive Rod Antenna	280	9003-2662	2023/02
EMCO Log Spiral 3101 Antenna	79	2495	NCR
EMCO 3120 Tuned Dipole Antenna B1	453	42	2023/02
EMCO 3121 Tuned Dipole Antenna B2	475	177	2023/02
EMCO 3121 Tuned Dipole Antenna B3	476	698	2023/02
EMCO Probe Set 7405	24	794	NCR
EMCO 3810/2NM LISN	601	9612-1740	2023/02
EMCO 3825/2R LISN	890	1031	2022/07
EMCO Voltage Probe 3701	499	9604-1130	2023/04
EMCO 3143 Biconilog	505	1266	NCR
EMCO 3146 Log Periodic Antenna	377	9203-3380	NCR
EMCO H-Field Probe	900	N/A	NCR
EMCO E-Field Probe	901	N/A	NCR
ENI Amplifier Model 510L	138	157	NCR
ENI Amplifier Model 600L	568	298	NCR
ETS 3142c Biconilog Antenna (Site B)	769	00046673	2023/01
ETS 3117 Ridge Guide Antenna	801	58877	2023/02
ETS 6512 Loop Antenna	787	00051667	2022/11
ETS Lindgren T.I.L.E. 4! Software Version 4.0.A.9 (only for classified tests)	N/A	N/A	NCR
ETS Lindgren T.I.L.E. Software Version 7.6.2.3	N/A	N/A	NCR
Fairgate Meter Stick	836	N/A	2023/02
FCC 150-50 Ohm Adapters	361	4	UWC
FCC 801-M3-25A Power Line Coupling/Decoupling Network	622	99125	2022/06
FCC 801-150-50 CDN	583	9975	UWC

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FCC 801-150-50 CDN	582	9976	UWC
FCC 50-150 Ohm Adapter	486	276	UWC
FCC 50-150 Ohm Adapter	487	277	UWC
FCC 801-T4 Coupling Network	485	45	UWC
FCC 801-T2 Coupling Network	484	50	UWC
FCC 801-AF2 Coupling Network	483	35	UWC
FCC 801-150-50-BCI Adapter	702	343	UWC
FCC 801-150-50-BCI Adapter	775	449	UWC
FCC 801-150-50-BCI Adapter	776	450	UWC
FCC 801-M2-25 Coupler/Decoupler	363	1	UWC
FCC 150-50 Ohm Adapter	362	2	UWC
FCC 801-M3-16A CDN	912	100835	2022/07
Fischer Custom Comm. Model 5-10-1-01-CISPR 25 LISN	728	03073	2022/09
Fischer Custom Comm. Model 5-10-1-01-CISPR 25 LISN	729	03074	2022/09
Fluke Multimeter Model 45	772	8750022	2023/06
GE Transformer 9T23B3871	N/A	N/A	NCR
Haefely Psurge 4010 Generator	736	151542	2023/04
Haefely PHV 41.1 PEFT.1 Generator	489	082-106-18	2022/11
Haefely FP16/3-1 Coupling Filter	356	082-208-02	UWC
Haefely PC-288.1 Generator	357	081-813-10	UWC
Haefely IP4 Coupling Clamp	481	N/A	NCR
Haefely Metallic Surge Pistol	643	N/A	UWC
Haefely Fp20/3-3 Coupling Filter	358	082-170-06	UWC
Haefely IP 6.2 I/O Coupling Network	928	080-260-03	CPU
Hughes 1277H09F000 Amplifier	N/A	082	NCR
Hughes 8101H11F000 18-26.5GHz Amplifier	230	039	NCR
Hughes 8010H12F000 26.5-40GHz Amplifier	231	051	NCR
IFI EFG-3B Billboard Antenna	122	453B	NCR
Integrity Design Geomagnometer IDR-321	743	1962	2022/05
Keithley 2750 Multimeter Switch System	1102	4125318	2023/02
Keithley Picoammeter 6487	1103	4385243	2023/02
Keysight InfiniVision MSO-X 3104A Oscilloscope	1017	MY53480275	2022/10
Keysight 10x Passive Probe N2890A	1018	N/A	2022/10
Keysight 10x Passive Probe N2890A	1019	N/A	2022/10
Keysight PNA N5225A Network Analyzer (Note: only cal'd to 40GHz)	1024	MY51451461	2022/10

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Keysight 11581A Attenuator Set	310, 311, 847, 899	N/A	2023/06
Keysight/Agilent/HP True RMS Multimeter U1242B	1089	MY60480049	2023/02
Keysight N2893A Probe	1091	JP60071205	2022/05
Keysight N2870A Passive Probe	1093	N2870-6001	2023/05
Keytek MZ-15 ESD Simulator	366	8801209	2023/01
Keytek VCP-1 Vertical Coupling Plane	368	9209332	NCR
Keytek CTC-3 Coax Monitor	440	N/A	NCR
Laplace Instruments AC2000A Power Analyzer	1087	311372	2023/04
Lietz Compass 8022-05	353	N/A	NCR
Logimetrics A300/C 4-8GHz	91	3093	NCR
Logimetrics A300/IJ Amplifier 7-18GHz	134	3094	NCR
Logimetrics A300/L (1-2 GHz)	135	3091	NCR
Logimetrics A300/S (2-4 GHz)	92	3092	NCR
MA/COM EWAL 1050-32 100-500MHz Amp	137	7364-1-001	NCR
MA/COM EWAL 5010-32 500-1000MHz Amp	136	7264-1-001	NCR
Miteq LNA AM-4A-000110	332	93739	2022/05
Mitutoyo 500-197-30 Caliper	1033	B16025736	2023/04
Narda 8616 Radiation Hazard Meter	417	27087	NCR
Narda 8621D Radiation Hazard Probe	428	27072	NCR
Narda 8661 Radiation Hazard Probe	416	04005	NCR
Narda 769-10 10dB 150 Watt Attenuator	221	03A26	2023/04
Narda 768-20 20dB 20Watt Attenuator	796	0110	2023/03
Narda 768-20 20dB 20Watt Attenuator	792	8902	2023/03
Narda 776C-20 Attenuator	N/A	2759	NCR
Narda 769-20 150 Watt Attenuator	471	02951	NCR
Narda 769-20 150 Watt Attenuator	222	02950	NCR
Narda 3020A Directional Coupler	214	34514	2022/06
Narda 3022 Directional Coupler	212	73360	2023/04
Narda 3022 Directional Coupler	814	81864	2022/09
Narda 3024 Coupler	1016	08017	2022/08
Narda 374BNM 50 Ohm Termination	1034	N/A	2023/05
Narda 374BNM 50 Ohm Termination	1035	N/A	2023/05
Narda 374BNM 50 Ohm Termination	1036	N/A	2023/05
Narda 374BNM 50 Ohm Termination	1037	N/A	2023/05
Narda 374BNM 50 Ohm Termination	1038	N/A	2023/05
Narda 374BNM 50 Ohm Termination	1039	N/A	2023/05
Narda Termination DC-18GHz	1075	N/A	2023/05
Narda Termination DC-18GHz	1076	N/A	2023/05

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Ohmite D225K250 variable resistor	N/A	N/A	NCR
Ohmite D1000K100 variable resistor	N/A	N/A	NCR
Ohmite RRS125 variable resistor	N/A	N/A	NCR
Omega Magnetic Field Meter HHG191	1077	180103103	2023/05
Ophir GRF5060 25 Watt Amplifier 0.8-4.2GHz	Rental	1004	NCR
Pasternack PE7014-3 (3dB) attenuator	N/A	N/A	NCR
Pasternack PE7014-6 (6dB) attenuator	N/A	N/A	NCR
Pasternak SE Lab N Cable	N/A	794	2023/01
Pasternak 18-40GHz FCC Cable	1072	N/A	2022/06
Pasternack 15' N-cable	1090	N/A	2022/06
Pasternak 7015-20 20dB Attenuator (CE102/CS114)	1061	N/A	2021/12
Pearson Electronics Powerline Ripple Detector Prd-240	1029	82197	2022/11
Polarad/ Rohde & Schwarz MDS21 Absorbing Clamp	435	301 404/003	2023/01
Polarad/Rohde & Schwarz ESH2-25 Artificial Mains Network	23	890484/016	2023/02
Pomona 50Ω Load Model 3840	1040	N/A	2023/05
Pomona 50Ω Load Model 3840	1041	N/A	2023/05
Pomona 6498 Voltage Probe	979	N/A	2022/09
Pomona 6498 Voltage Probe	980	N/A	2022/09
Pomona 6492 Voltage Probe	978	N/A	2022/09
Pomona 6498 Voltage Probe	1125	N/A	2023/06
Powerstat Variable Transformer 12560T	506	N//A	NCR
Quad-Tech 1433-00 Decade Resistor	318	5037519	2022/11
Quinstar QGH-QPRROO 33GHz to 50GHz Horn Antenna	1078	N/A	NCR
Quinstar QGH-QPRROO 33GHz to 50GHz Horn Antenna	1079	N/A	NCR
Quinstar QWH-VPROO 50GHz-75GHz WR15 Horn Antenna	1006	8157001	NCR
Quinstar QGH-VPRROO 50GHz-75GHz WR15 Horn Antenna	1070	N/A	NCR
RF Power Labs 220-1K60L 1kW Amplifier	35	042594-1	NCR
RF Power Labs Pre Amp	562	N/A	NCR
RF Power Labs 20 Watt Power Amplifier	563	N/A	NCR
Rigel Electrosurgical Analyzer Model 377	929	O2C-0572	2022/11
Rohde and Schwarz ESIB 40 EMI Test Receiver	803	100293	2023/05
Rohde and Schwarz Signal Generator	881	883 802/013	2022/06
Rohde and Schwarz ESCI7	902	100747	2023/04
RS Components Variac Transformer	885	N/A	NCR

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Schaffner NSG 438 PN 400-348 ESD Simulator	755	385	2023/03
Schaffner INA 4380 150pF/330Ohm Network	756	403-550-0447	2023/03
Schaffner INA 4480 Magnetic Loop	763	403-615-0413	UWC
Schaffner INA 4553 330pF/330Ohm Network	759	403-588-0447	2023/03
Schaffner INA 4597 100pF/47Ohm Network	955	892	2023/03
Schwarzbeck HFRA 5164	1095	00022	2022/06
Schwarzbeck FESP 5134-1 Magnetic Field Sensor	1094	00062	2022/06
Schwarzbeck Compensation Network NFCN 1356	1101	00052	NCR
Sharp Closed Circuit Video Monitor	N/A	N/A	NCR
Simpson Leakage Current Tester Model 228	958	N/A	2023/02
Singer CLS-105 Log Spiral Antenna	89	00316-4780	NCR
Singer CLS-105 Log Spiral Antenna	83	00315-5007	NCR
Solar 2854-2 Spike Generator	Rental	223161-1	2022/09
Solar 50 Ohm/50uH L.I.S.N.	19	894304	2023/02
Solar 50 Ohm/50uH L.I.S.N.	20	894305	2023/02
Solar 50 Ohm/50uH L.I.S.N.	21	894307	2023/02
Solar 6220-1A Audio Isolation Transformer	170	N/A	NCR
Solar Model 8105 0.001 Ohm Resistor	179	N/A	2023/01
Solar Model 8105 0.001 Ohm Resistor	308	N/A	2023/01
Solar Model 7122 1 Ohm Resistor	297	N/A	2023/01
Solar Model 7122 1 Ohm Resistor	300	N/A	2023/01
Solar Model 7122 1 Ohm Resistor	301	N/A	2023/01
Solar Model 7144 5 Ohm Resistor	299	N/A	2023/01
Solar Model 7144 10 Ohm Resistor	298	N/A	2023/01
Solar Model 7144 10 Ohm Resistor	302	N/A	2023/01
Solar 6512-106R 10uF Capacitor	387	N/A	2023/01
Solar 6512-106R 10uF Capacitor	389	N/A	2023/01
Solar 6512-106R 10uF Capacitor	390	N/A	2023/01
Solar 6512-106R 10uF Capacitor	391	N/A	2023/01
Solar 6512-106R 10uF Capacitor	392	N/A	2023/01
Solar 6512-106R 10uF Capacitor	393	N/A	2023/01
Solar 6512-106R 10uF Capacitor	394	N/A	2023/01
Solar 7012-106R 10uF Capacitor	186	N/A	2023/01
Solar 7012-106R 10uF Capacitor	187	N/A	2023/01
Solar 7012-106R 10uF Capacitor	188	N/A	2023/01
Solar 7012-106R 10uF Capacitor	189	N/A	2023/01
Solar 7012-106R 10uF Capacitor	190	N/A	2023/01
Solar 7012-106R 10uF Capacitor	191	N/A	2023/01

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Solar 7012-106R 10uF Capacitor	723	N/A	2023/01
Solar 7012-106R 10uF Capacitor	724	N/A	2023/01
Solar 6512-106R 10uF Capacitor	807	N/A	2023/01
Solar 6512-106R 10uF Capacitor	808	N/A	2023/01
Solar 6512-106R 10uF Capacitor	809	N/A	2023/01
Solar 6512-106R 10uF Capacitor	810	N/A	2023/01
Solar 6512-106R 10uF Capacitor	811	N/A	2023/01
Solar LISN 8028-50-TS-24-BNC/461	381	852334	2023/02
Solar 50 Ohm/50uH L.I.S.N.	382	860622	2023/02
Solar LISN 8028-50TS-24-BNC	383	860623	2023/02
Solar LISN 8028-50-TS-24-BNC/461	384	8305125	2023/03
Solar LISN 8028-50TS-24-BNC	385	8379275	2023/03
Solar LISN 8028-50TS-24-BNC	805	062632	2023/03
Solar LISN 8028-50TS-24-BNC	806	062633	2023/03
Solar 8016-50-TS-100N LISN	907	100755	2023/06
Solar 8016-50-TS-100N LISN	908	100754	2023/06
Solar Coupling Probe Type 9335-2	753	0401507	UWC
Solar Coupling Probe Type 9144-1N	857	078003	UWC
Solar Coupling Probe Type 9142-1N	893	089816	UWC
Solar Calibration Fixture Type 9357-1	754	N/A	UWC
Solar Calibration Fixture Type 9125-1	894	N/A	NCR
Solar 9134-1 Current Probe	880	089523	2023/03
Solar 9355-1 Pulse Generator	740	041224	UWC
Solar 9354-1 Damped Sinusoid Generator	739	940559	UWC
Solar 9554-10k/100k Module	N/A	077604	UWC
Solar 9554-1M/6M Module	N/A	077804	UWC
Solar 9554-6M/50M Module	N/A	077904	UWC
Solar 9554-50M/100M Module	N/A	023815	UWC
Solar Loop Antenna 7429-1	163	138	2022/07
Solar Loop Sensor Antenna 7334-1	164	945212	2022/07
Solar Loop 9229-1 with 9230-1	201, 175	006705, 031101	2022/07
Solar Current Probe 6741-1	468	901610	2023/03
Solar 6552-1A Audio Amplifier	162	829015	NCR
Solar 6220-4 Audio Isolation Transformer	816	N/A	NCR
Solar 6220-4 Audio Isolation Transformer	817	N/A	NCR
Solar High Pass Filter 7930-5.0	781	N/A	2023/01
Solar 8614-1 Line Probe	178	932724	2022/06
Solar 9226 0.5 Precision Resistor Assembly	176	N/A	2022/07

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Sorenson DCR40-60A DC Power Supply	185	1458	NCR
Spacek SLKKA-50-6 18GHz-40GHz LNA	930	1D13	2022/06
Staco 3PN 1520B Variac	635	N/A	NCR
Storm 90-010-722 Microwave coaxial cable	N/A	N/A	UWC
Suhner Sucoflex 100 Microwave cable	N/A	N/A	NCR
Suhner Sucoflex 102 Microwave cable	N/A	N/A	NCR
Tegram Bulk Current Injection Probe 95252-1	490	12180	UWC
Tegram B. C. I. Probe Calibrator 95251-1	507	12326	UWC
Tektronix 7A29 1GHz Vertical Amplifier	153	B040385	NCR
Tektronix TDS 380 Oscilloscope	516	B012231	2022/09
Tektronix P6114B Voltage Probe	837	N/A	2023/06
Tektronix TB92A Time Base	196	B096042	NCR
Testec HVP-15HF High Voltage Probe	1027	20151109	2022/10
Testec HVP-15HF High Voltage Probe	1026	20152029	2022/10
Topaz 910002-32 Isolation Transformer	009	N/A	NCR
Topaz 910002-32 Isolation Transformer	118	N/A	NCR
Valhalla 4100ATC Digital Ohmmeter	158	2-2818	2023/02
Vaisala Pressure, Humidity, Temperature Transmitter PTU301-300	850	C3850004	2023/03
VDI WR10 Calibration Kit N5262AC10	1048	US54410139	NCR
VDI WR15ibration Kit N5262AC15	1049	US54410108	NCR
VDI WR10 Mini Tx/Rx Module N5262BW10-STD	1050	US54250101	NCR
VDI WR10 Mini Tx/Rx Module N5262BW10-STD	1052	US54250102	NCR
VDI WR15 Mini Tx/Rx Module N5262BW15-STD	1053	US54250002	NCR
VDI WR15 Mini Tx/Rx Module N5262BW15-STD	1054	US5425003	NCR
Voltech PM6000 Power Analyzer	861	100006700235	2022/08
Watrous/Durotherm Hygrometer	496	N/A	2023/04
Watrous/Durotherm Hygrometer	497	N/A	2023/04
Watrous/Durotherm Hygrometer	498	N/A	2023/04
Watrous/Durotherm Thermometer	605	N/A	2023/03
Watrous/Durotherm Thermometer	606	N/A	2023/03
Watrous/Durotherm Thermometer	607	N/A	2023/03
Watrous/Durotherm Thermometer	581	N/A	2023/04
Werlatone C6277-10 Directional Coupler	780	20250	2022/09
Werlatone C6177 Directional Coupler	731	14304	2022/10
Werlatone C3908-10 Dual Directional Coupler	813	35594	2022/09
Werlatone C6442-10 Dual Directional Coupler	982	106459	2022/10

APPENDIX B: TEST LOG

TEST LOG

Customer: Specialty Materials Business Unit
Equipment: Cho-Bond 1018/1019 Conductive Compound
Program: Shielding Effectiveness
Tested By: Dung Pham/Nick Orphanos

Pre-Test Checklist	Date	Comments				
	2020-01-14	Test Plan/Procedure: IEEE-STD-299 Chomerics Procedure: N/A Environmental: Bonding/Grounding: N/A Safety Issues: N/A				
In-Process Test Checklist	Date	Test Type	Test Equipment Calibrated	Test Performed Properly – Data Accepted	MUT Set-up Check/ Operational Check	EUT Pass/ Fail
	2021-09-21	SE Open References	Yes	Yes	Yes	N/A
	2021-09-21	SE	Yes	Yes	Yes	N/A
	2021-11-02	SE	Yes	Yes	Yes	N/A
Post Test Checklist	Date: 2021-11-02	MUT Functional Operation Check: N/A		Dungpham Test Engineer/Tech	David C Lemmon Approved Signatory	

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