CHO-TP10
2-17-2010

TEST PROCEDURE TO MEASURE THE TRANSFER IMPEDANCE PERFORMANCE OF

EMI GASKETS

INCLUDING ENVIRONMENTAL EXPOSURE

Parker Hannifin Corporation
Chomerics Division
Chomerics Test Services
77 Dragon Court
Woburn, MA 01801

Table of Contents

List of Figures

List of Tables

List of Drawings

Parker Chomerics

1.0 PURPOSE

1.1 This is a test method for performing transfer impedance measurements on commercial grade EMI gaskets in strip and sheet form before and after environmental exposure. Materials that can be evaluated using this technique include homogeneously conductive gaskets (molded, extruded and/or Form in Place (FIP)), and conductive fabric, and/or coating over non-conductive core gaskets. Injected current methods are used to determine shielding effectiveness.

The environmental exposure can include temperature cycling, humidity cycling and/or salt fog or any combination thereof. Exposure of conductive elastomer/mating flange combinations to harsh environmental conditions (e.g., corrosive, high temperature or fuel laden) may result in physical or electrical degradation of the conductive elastomer or mating flange or both which can lead to a loss in shielding effectiveness.

Different from other existing test procedures, this test procedure was developed to be able to include environmental exposure cycling of the gasket assembly without disassembly.

1.2 This test method covers fixture design, specimen preparation, and instrumentation to characterize a conductive gasket system for shielding effectiveness. The fixture was fabricated in accordance with ARP 1705.

1.3 The gasket materials applicable to this test method are: conductive elastomer materials (homogeneous); conductive coat over silicone core (reticular); knitted wire over a sponge core materials; and knitted conductive yarn over a sponge core materials. Cross-Sectional dimensions are limited to less than .350 inch.

1.4 This test method does not replicate the mechanical and/or electrical performance of a gasket in an actual electronic enclosure, but does allow evaluations of variation in gasket materials in a standardized setup.

2.0 APPLICABLE DOCUMENTS

The following documents are applicable to the extent described in this document.

2.1 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.

3.0 SIGNIFICANCE AND USE

3.1 Conductive EMI gaskets are used to seal apertures in electronic enclosures against leakage of electromagnetic radiation. Metal-filled elastomers (homogeneously conductive elastomers) are one type of EMI gaskets used for this purpose. Conductive elastomers consist of small (typically, 30 to 150 microns) metal particles dispersed in an elastomer binder. Typical metal fillers include silver, silver plated materials (e.g., copper, glass, aluminum, nickel), nickel, and carbon. Typical binders include silicone and flourosilicone. The elastomer binder is highly loaded with the metal filler to provide low volume resistivity. A second type of EMI gasket material incorporates a conductive coating or covering around a non-conductive core. The conductive layer can be in the form of a coating filled with conductive particles, a knitted or woven conductive fabric, or wire mesh.

3.2 This method is intended to provide a controlled test for comparison of different gasket/coating materials in a standardized setup.

3.3 The transfer impedance is determined using a coaxial induced current technique. This technique involves a bench-top test jig and removable test plate pair that compresses the sample gasket. The removable test plate pair is inserted into the test jig. An rf signal is applied to the 50Ω series input connector of the removable test plate pair, and the output voltage from the test jig is measured. The sample gasket serves to shunt the applied signal to the jig housing (ground), therefore, the lower the resistance of the gasket the lower the voltage measured (lower transfer impedance). From there the transfer impedance is calculated for a given length of gasket material and is expressed in Ohm-meters or milli-Ohm-meters.

4.0 TEST PREPARATION

4.1 Test Plates

4.1.1 Multiple test plates to make up multiple removable test plate pairs are required. The test plates consist of 6061-T6 aluminum.

4.1.2 These test plates, illustrated in Drawings 1, 2 and 3, are suited for insertion into the test jig, Drawing 4.

4.1.3 In addition to the test plates, plastic washers around the plastic bolts are used as “spacers” that are sized to allow proper deflection of the various gasket sizes. An assortment of test plates with spacers of differing thickness will allow different gaskets to be evaluated under their proper deflection parameters. These spacers are designed to fit around the (3) plastic bolts of the removable test plate sets.

4.1.4 The following test plates, in addition to the test jig shown in Drawing 4, have been designed (dimensions in inches):

A. The Base plate illustrated in Drawing 1 is used to hold the rf input connector or nylon plug, and allows the assembled removable plate fixture to be pressed to the test jig housing. The bolt pattern of this plate mates with the bolt pattern on the contact plate (Section B below). This plate is 0.5 inches thick.

B. The Contact plate illustrated in Drawing 2 is also made of aluminum and is 0.250 inch thick. This plate makes up the second half of the Removable Plate Set.

C. The Test Plate Sets are made up of two aluminum plates as illustrated in Drawing 3. The plate set is then inserted into a test jig as shown in Drawing 4. The Test Plate Set is held in place by two toggle clamps pressing down on the Base Plate.

The gasket and flange treatment (or “test plate set”) is designed so that the transfer impedance measurements and environmental exposure can be done without disassembly of the “test plate set”.

The mating flange area of the gasket can be treated with chromate, nickel, tin or conductive coating. The flange treatment information shall be included in the test report.

Deflection of the gasket material is controlled by adding plastic (non-conductive) washers, of proper thickness, around the (3) plastic bolts of the removable test plate sets.

Plastic fasteners (bolts) are used in all cases.

4.2 Sample Gasket Preparation

4.2.1 This test method is designed to test extruded and form in place gaskets of varying cross-sections as well as sheet stock. Each gasket is tested between Test Plates 2 and 3 defined above.

For the Solid "D" Extrusion conductive elastomer which is 0.175 inches high by 0.178 inch wide, the non-conductive shims are sized with a thickness providing a nominal gasket deflection that is 13.1%, a maximum deflection that is 16.7%, and a minimum deflection that is 8.2%.

Deflection requirements for other gasket types are to be specified by the requestor.

Tests can also be performed with conductively coated non-conductive core gaskets. In addition, Form in Place (FIP) gaskets can be tested by dispensing directly on one of the Test Plates.

4.2.2 The gasket configuration (not cross-section) is either 1) two 3 inch long strips or 2) one 3 inch by 3 inch sheet with a 0.25 inch hole in the center.

4.2.3 The actual test gasket cross section is to be defined in the test report along with the gasket deflection information. Gasket deflection should be as specified by the requestor and under nominal gasket deflection conditions.

Different gasket deflections can be achieved by fabricating spacers that are designed to fit around the (3) plastic bolts of the removable test plate sets.

4.3 The test jig needs to meet the mechanical parameters detailed in Drawing 4.

4.4 Table 1 lists typical equipment that can be used for this type of test. Due to factors such as rotation within the calibration cycle, repairs, out of service equipment, and dynamic range considerations, any of the equipment listed within this table may be substituted for another piece of equipment of similar function. A detailed list of the exact equipment used and date of calibration shall be noted in the test report. If attenuators are determined to be necessary at the time of test, then their location within the test setup and value will be noted on the test data sheet and within the test report.

5.0 VOLTAGE MEASUREMENTS AND TRANSFER IMPEDANCE CALCULATION

5.1 Each gasket material Test Plate Set to be tested should be mounted onto the adapter plate of the test jig after open reference measurement. The mounting bolts (fasteners) should be tightened as much as possible to the compression stop without stripping, stretching or breaking. Each gasket tested will be deflected properly, as controlled by the compression stop installed between the test sets.

5.2 The test should be performed at frequencies of 10kHz, 20kHz, 40kHz, 60kHz, 80kHz, 100kHz, 200kHz, 400kHz, 600kHz, 800kHz, 1MHz, 2MHz, 4MHz, 6MHz, 8MHz, 10 MHz, 20MHz, 40 MHz, 60 MHz, 80 MHz, 100 MHz, 200 MHz, 400 MHz, 600 MHz, 800 MHz, and 1 GHz. Swept frequency test techniques are acceptable.

The gasket length (inches or meters) and calculated transfer impedance, expressed in both (dB Ω-m) and (Ω-m), should be noted on the test data sheet. For manual measurements at discrete frequency points, the initial input voltage and test jig output voltage should also be recorded for each data point.

5.3 Transfer Impedance values are calculated based on three variables: 1) input voltage to the test plate set, 2) the final voltage measurement out of the test plate set, and 3) total gasket length. The input voltage measurement shall be taken as follows:

The actual test of the material involves three main pieces of equipment: 1) signal generator, 2) test plate set in jig, and 3) spectrum analyzer. This is illustrated in Figure 1. To obtain the input voltage to the test jig, the three cables in the figure are first daisy chained together and connected directly from the signal generator to the spectrum analyzer, bypassing the test jig as shown in Figure 2. Then, with the signal generator output voltage held constant, the spectrum analyzer voltage level is recorded for each frequency under test. These recorded levels are the input or “reference signal” levels.

5.5 Final measurements at the same frequencies and signal generator levels used for the reference tests are to be performed as illustrated in Figure 1. Note the use of the optional pre-amplifier at the input to the spectrum analyzer.

5.6 The transfer impedance is calculated using the following equation:

$Z_t = V_0 - (V_i - 34) + 20\log L_g$ (dB Ω-m)
Where,
V_0 = Measured Voltage out of jig
V_i = Level of input voltage to jig
L_g = Length of gasket in meters

As an example, for
V_i = +20dBm, V_0 = -100dBm, and
L_g = 6 inches (two 3-inch strips),

$Z_t = -100 - (20 - 34) + 20\log(.1515\text{m})$
$Z_t = -86 - 16.39 = -102.39$ dB Ω-m
$Z_t = \text{antilog}(-102.39/20) = 7.6$uΩ-m

6.0 ENVIRONMENTAL EXPOSURE

6.0 After initial shielding effectiveness measurements, the test plate sets can be exposed in any environmental condition and then retested. Examples of environmental exposures are

1. Dry Heat Aging
2. Heat and Humidity Aging

When incorporating environmental cycling, consider protecting the flange area of the test sets which is mated to the shielded enclosure. This will help ensure this area of the flange is clean and dry to optimize the electrical connection to the shielded enclosure.

7.0 TEST REPORT

7.1 Detailed test data sheets are to be inserted into the test report. The test data sheets will include the test results, the name of the person who performed the test, and identification/description of the material under test. Refer to Table 2 for an example of the test data sheet.

7.2 Any deviation from this procedure should be noted on the test data sheet and within the test report. A full explanation of the deviation and the corrective action taken should also be provided on the test data and in the test report.

7.3 The Test Report shall contain the list of test equipment used and date of calibration as well as photographs of the test setup.

TEST EQUIPMENT		
MANUFACTURER	Model #	Description
Agilent (Hewlett Packard)	83620B	Signal Generator
Agilent (Hewlett Packard)	3326A	Signal Generator
Agilent (Hewlett Packard)	4440A	Spectrum Analyzer
Agilent (Hewlett Packard)	8447F	RF Pre-Amplifier
Chomerics	N/A	ARP 1705 Test Fixture/Jig
Generic	N/A	50Ω BNC Cables
ETS-Lindgren	N/A	Tile or similar pc based automated SW

TABLE 1

Customer: R&D
Product Tested: 4459-35-40
Tested by: B Couture
Date: Sep-09

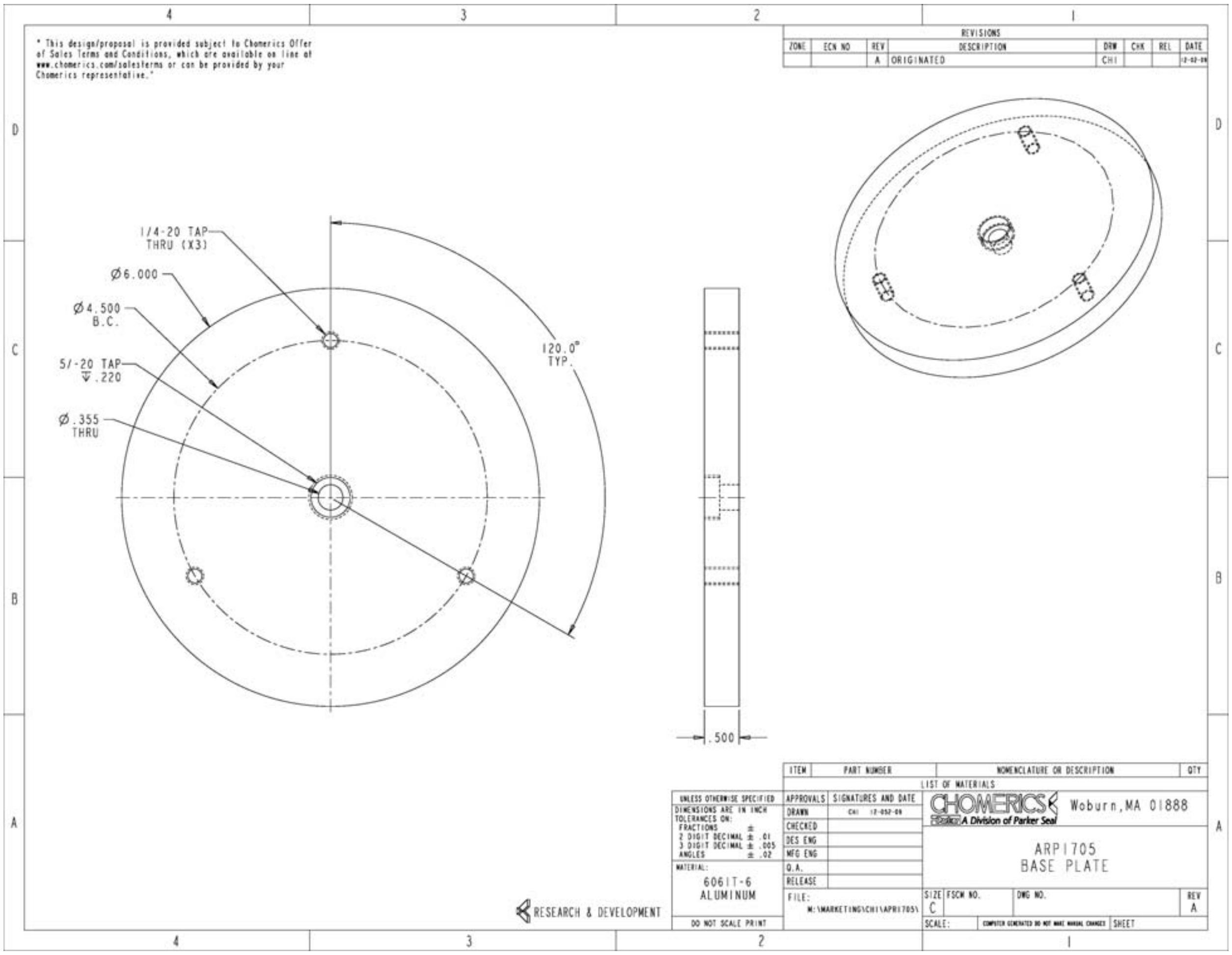
Two 3" gasket strips
Chomerics Material: 1350 Cr6

Frequency (MHx)	Zt (dB Ω-m) Initial	Zt(dB Ω-m) 300hrs	Zt(dB Ω-m) 1000hrs	Zt (Ω-m) Initial	Zt (Ω-m) 300hrs	Zt (Ω-m) 1000hrs
0.010	-38.7	-36.1	-14.9	0.0116611	0.0156576	0.1802372
0.020	-38.6	-35.6	-14.9	0.0117631	0.0166455	0.1794470
0.040	-38.7	-35.3	-14.9	0.0116270	0.0172439	0.1806072
0.060	-38.7	-35.2	-14.8	0.0115936	0.0173894	0.1819847
0.080	-38.7	-35.2	-14.8	0.0116084	0.0174395	0.1825093
0.100	-38.7	-35.2	-14.8	0.0115723	0.0174476	0.1817126
0.200	-38.6	-35.1	-14.8	0.0116834	0.0175100	0.1823624
0.400	-38.7	-35.1	-14.8	0.0116633	0.0174918	0.1819638
0.600	-38.7	-35.2	-14.8	0.0116565	0.0174435	0.1818379
0.800	-38.7	-35.2	-14.8	0.0116619	0.0173614	0.1809609
1	-38.6	-35.2	-14.8	0.0117184	0.0174636	0.1814408
2	-38.6	-35.3	-14.8	0.0117252	0.0171824	0.1819638
4	-38.5	-35.5	-14.8	0.0118446	0.0168262	0.1815244
6	-38.7	-35.8	-15.1	0.0116713	0.0162568	0.1757458
8	-38.7	-36.0	-15.4	0.0116552	0.0159325	0.1706218
10	-38.5	-36.0	-15.5	0.0118528	0.0158959	0.1681454
20	-38.1	-34.9	-16.8	0.0124185	0.0179013	0.1441402
40	-37.7	-35.2	-17.7	0.0130203	0.0173175	0.1308232
60	-36.3	-36.4	-18.8	0.0153275	0.0150564	0.1145877
[illegible]	[illegible]	[illegible]	-19.1	0.0161523	0.0172518	0.1114628
[illegible]	[illegible]	[illegible]	-19.7	0.0166661	0.0168941	0.1032600
200	-34.5	-36.5	-25.1	0.0188727	0.0149441	0.0553462
400	-36.2	-37.7	-30.3	0.0154657	0.0130969	0.0304183
600	-41.2	-40.3	-38.6	0.0087512	0.0096532	0.0117009
800	-44.5	-40.8	-52.2	0.0059713	0.0090849	0.0024562
1000	-38.3	-35.6	-43.6	0.0121052	0.0165432	0.0065897

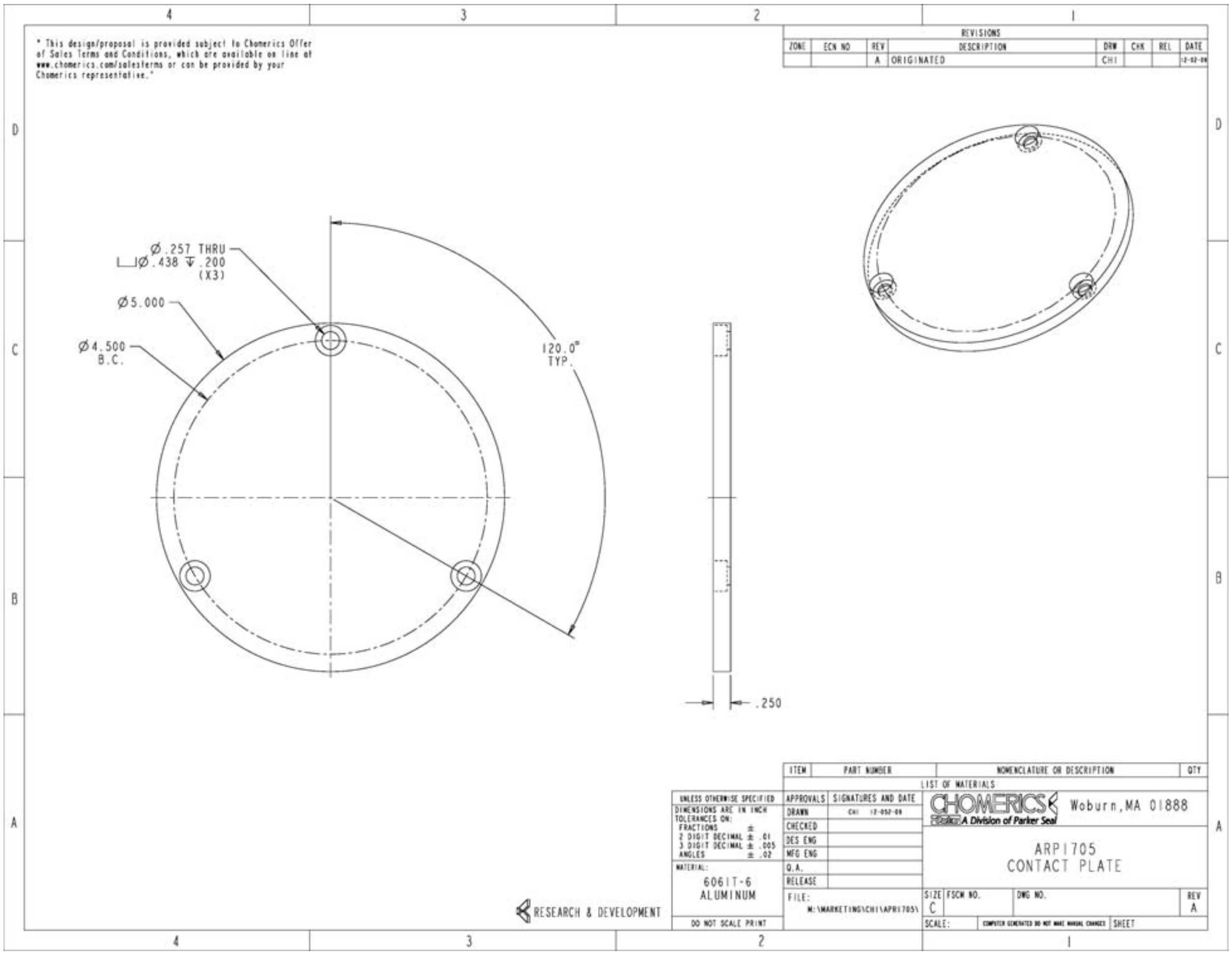
Parker Chomerics

TABLE 2

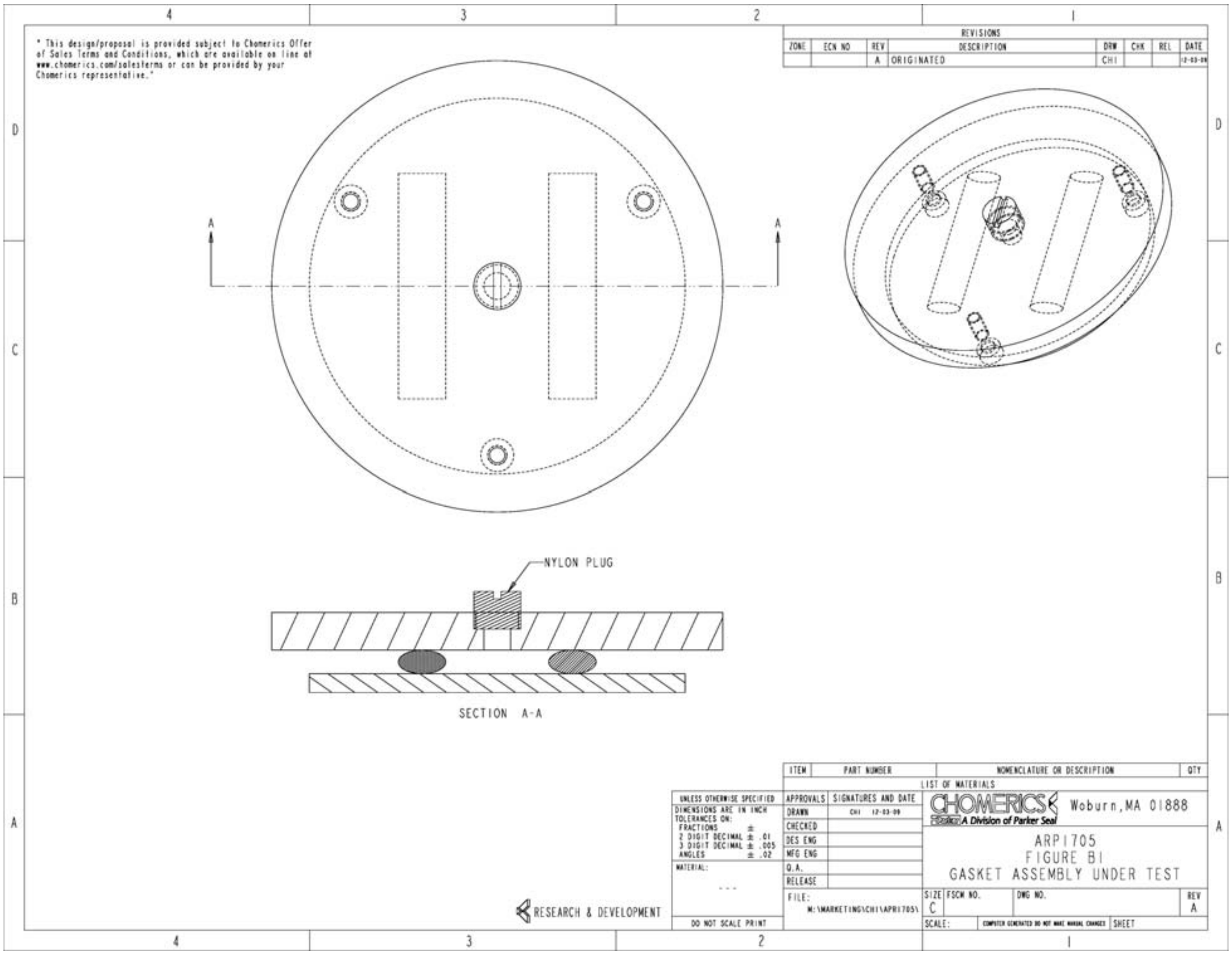
Chomerics, 77 Dragon Court, Woburn, MA 01801-4014 (781) 935-4850 FAX (781) 935-2758


* This design/proposal is provided subject to Chomerics Offer of Sales Terms and Conditions, which are available on line at www.chomerics.com/salesterms or can be provided by your Chomerics representative.*
1/4-20 TAP THRU (X3)
Ø6.000
Ø4.500 B.C.
5/-20 TAP ⊽.220
Ø.355 THRU
120.0° TYP.
.500
REVISIONS
ZONE | ECN NO | REV | DESCRIPTION | DRW | CHK | REL | DATE
A | ORIGINATED | CHI
ITEM | PART NUMBER | NOMENCLATURE OR DESCRIPTION | QTY
LIST OF MATERIALS
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCH
TOLERANCES ON: FRACTIONS ± 2 DIGIT DECIMAL ± .01 3 DIGIT DECIMAL ± .005 ANGLES ± .02
MATERIAL: 6061T-6 ALUMINUM
APPROVALS | SIGNATURES AND DATE
DRAWN | CHECKED | DES ENG | MFG ENG | Q.A. | RELEASE
CHOMERICS A Division of Parker Seal
Woburn, MA 01888
ARP1705
BASE PLATE
SIZE C | FSCM NO. | DWG NO. | REV A
FILE:
SCALE: | SHEET
DO NOT SCALE PRINT
RESEARCH & DEVELOPMENT

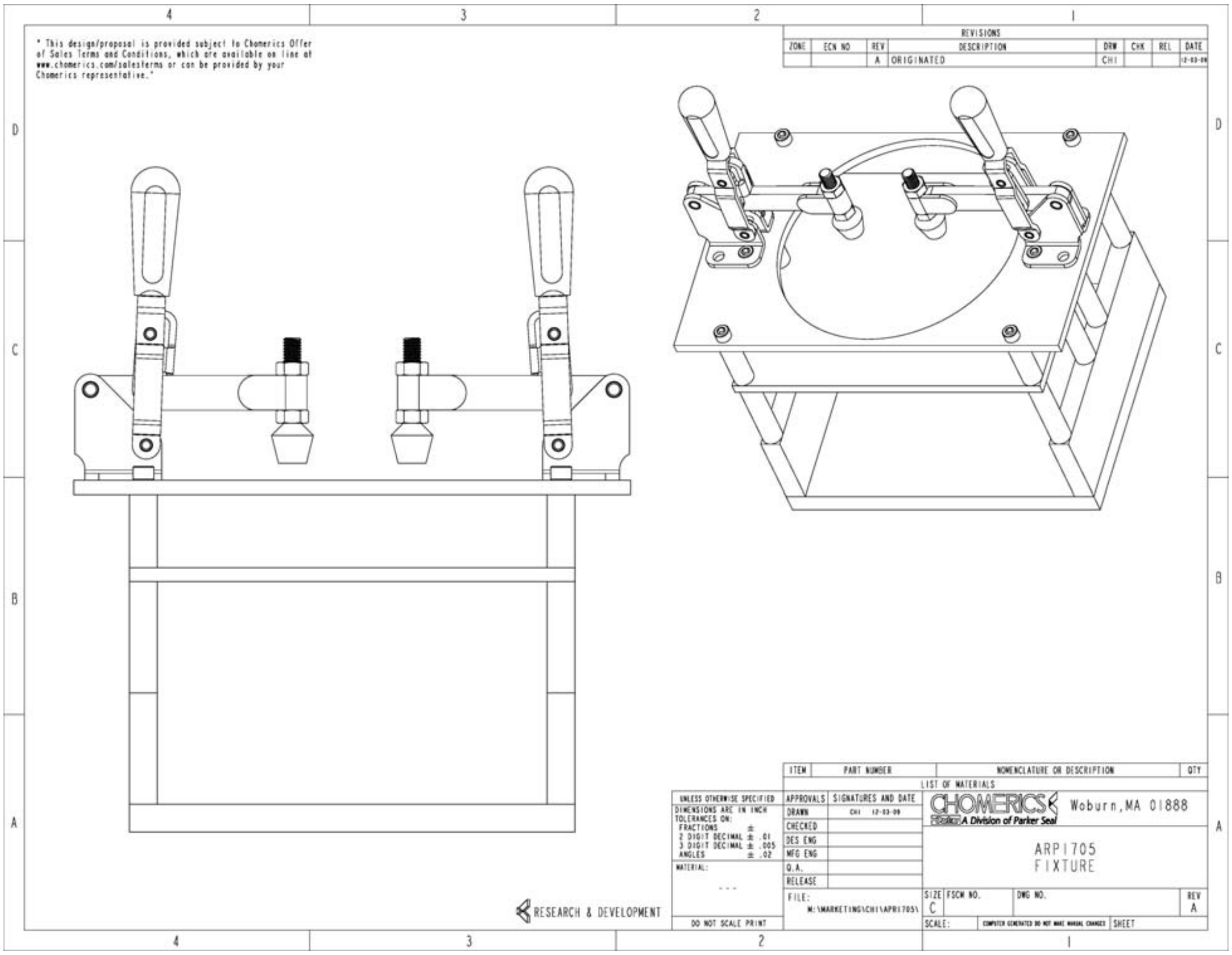
DRAWING 1


* This design/proposal is provided subject to Chomerics Offer of Sales Terms and Conditions, which are available on line at www.chomerics.com/salesterms or can be provided by your Chomerics representative.*
REVISIONS
ZONE
ECN NO
REV
DESCRIPTION
DRW
CHK
REL
DATE
A
ORIGINATED
CHI
Ø.257 THRU
⌴Ø.438 ↧.200
(X3)
Ø5.000
Ø4.500
B.C.
120.0°
TYP.
.250
ITEM
PART NUMBER
NOMENCLATURE OR DESCRIPTION
QTY
LIST OF MATERIALS
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCH
TOLERANCES ON:
FRACTIONS ±
2 DIGIT DECIMAL ± .01
3 DIGIT DECIMAL ± .005
ANGLES ± .02
MATERIAL:
6061T-6
ALUMINUM
DO NOT SCALE PRINT
APPROVALS
SIGNATURES AND DATE
DRAWN
CHECKED
DES ENG
MFG ENG
Q.A.
RELEASE
FILE:
M:\MARKETING\CHI\APR1705\
CHOMERICS
A Division of Parker Seal
Woburn, MA 01888
ARP1705
CONTACT PLATE
SIZE
C
FSCM NO.
DWG NO.
REV
A
SCALE:
COMPUTER GENERATED DO NOT MAKE MANUAL CHANGES
SHEET
RESEARCH & DEVELOPMENT

DRAWING 2


* This design/proposal is provided subject to Chomerics Offer of Sales Terms and Conditions, which are available on line at www.chomerics.com/salesterms or can be provided by your Chomerics representative."
REVISIONS
ZONE
ECN NO
REV
DESCRIPTION
DRW
CHK
REL
DATE
A
ORIGINATED
CHI
12-03-09
A
A
NYLON PLUG
SECTION A-A
ITEM
PART NUMBER
NOMENCLATURE OR DESCRIPTION
QTY
LIST OF MATERIALS
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCH
TOLERANCES ON:
FRACTIONS ±
2 DIGIT DECIMAL ± .01
3 DIGIT DECIMAL ± .005
ANGLES ± .02
MATERIAL:
DO NOT SCALE PRINT
APPROVALS
SIGNATURES AND DATE
DRAWN
CHI 12-03-09
CHECKED
DES ENG
MFG ENG
Q.A.
RELEASE
FILE:
M:\MARKETING\CHI\APR1705\
CHOMERICS
A Division of Parker Seal
Woburn, MA 01888
ARP1705
FIGURE B1
GASKET ASSEMBLY UNDER TEST
SIZE
C
FSCM NO.
DWG NO.
REV
A
SCALE:
COMPUTER GENERATED DO NOT MAKE MANUAL CHANGES
SHEET
RESEARCH & DEVELOPMENT

DRAWING 3


* This design/proposal is provided subject to Chomerics Offer of Sales Terms and Conditions, which are available on line at www.chomerics.com/salesterms or can be provided by your Chomerics representative."
REVISIONS
ZONE ECN NO REV DESCRIPTION DRW CHK REL DATE
A ORIGINATED CHI
ITEM PART NUMBER NOMENCLATURE OR DESCRIPTION QTY
LIST OF MATERIALS
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCH
TOLERANCES ON:
FRACTIONS ±
2 DIGIT DECIMAL ± .01
3 DIGIT DECIMAL ± .005
ANGLES ± .02
MATERIAL:
APPROVALS SIGNATURES AND DATE
DRAWN CHI 12-03-09
CHECKED
DES ENG
MFG ENG
Q.A.
RELEASE
CHOMERICS
A Division of Parker Seal
Woburn, MA 01888
ARP1705
FIXTURE
FILE:
M:\MARKETING\CHI\APR1705\
SIZE C
FSCM NO.
DWG NO.
REV A
SCALE:
COMPUTER GENERATED DO NOT MAKE MANUAL CHANGES
SHEET
DO NOT SCALE PRINT
RESEARCH & DEVELOPMENT

DRAWING 4

Parker Chomerics

TEST SETUP- VOLTAGE OUTPUT MEASUREMENT

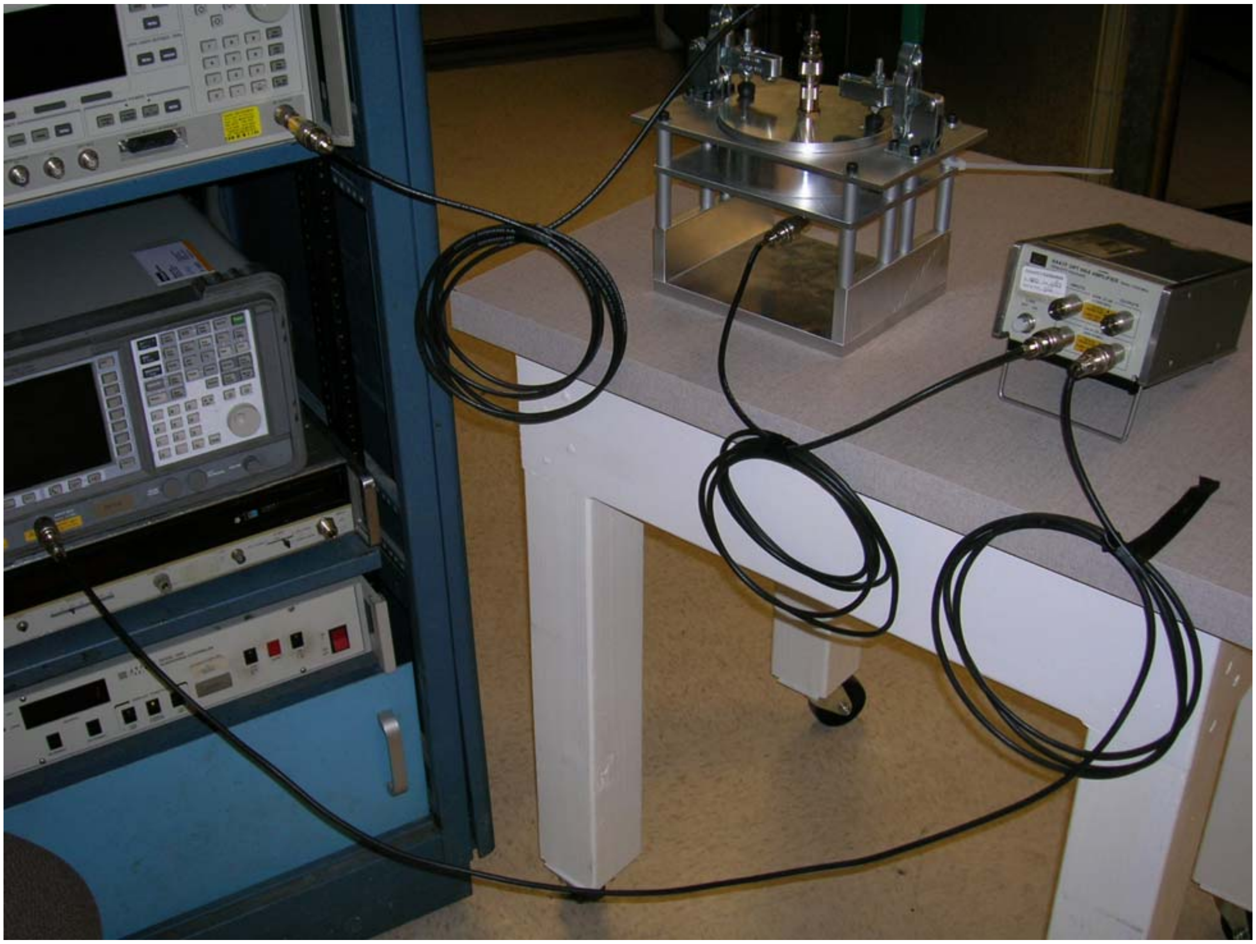


FIGURE 1

TEST SETUP- INITIAL INPUT VOLTAGE MEASUREMENT

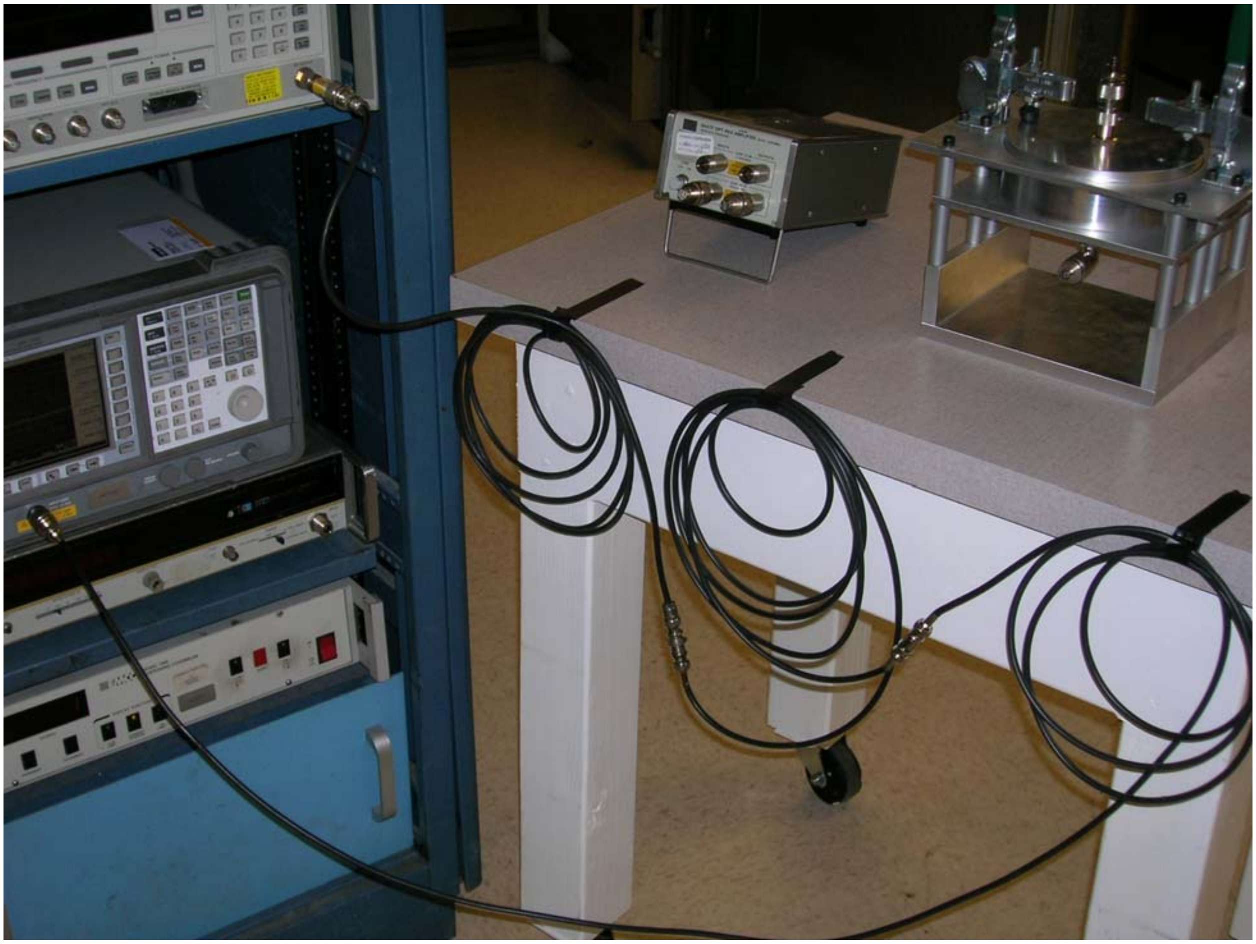


FIGURE 2