CHO-TP09
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TEST PROCEDURE TO MEASURE THE SHIELDING EFFECTIVENESS PERFORMANCE OF

EMI GASKETS

INCLUDING ENVIRONMENTAL EXPOSURE

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1.0 PURPOSE

1.1 This is a test method for performing shielding effectiveness measurements on commercial grade EMI gaskets in strip 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. Radiated 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.

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. 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.

2.0 APPLICABLE DOCUMENTS

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

2.1 CHO-TM-TP08: Shielding Effectiveness Test Method for Commercial Style EMI Gaskets, Revision A, April 1993.

2.2 IEEE Std 299-1997: IEEE Standard Method for Measuring the Effectiveness of Electromagnetic Shielded Enclosures, April 1998.

2.3 MIL-DTL-83528C: Military Specification: Gasketing Material, Conductive, Shielding Gasket, Electronic, Elastomer, EMI/RFI General Specification for, January, 2001.

2.4 MIL-C-5541E: Military Specification; Chemical Conversion

Coatings on Aluminum and Aluminum Alloys, 30 November 1990.

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 shielding effectiveness is measured using a radiated field technique. This technique involves two duplicate antennas with an aperture in the wall of a shielded room between them. A gasketed cover plate assembly completes the test setup.

4.0 TEST PREPARATION

4.1 Test Plates

4.1.1 Multiple test plates are required. The test plates consist of 6061-T6 aluminum.

4.1.2 These test plates, illustrated in Drawings 1, 2 and 3, adapt to the opening and bolt pattern of the shielded enclosure (test chamber).

4.1.3 In addition to the test plates, a plastic frame is used as a “spacer” which is 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, illustrated in Drawing 4, are designed to fit the bolt pattern of the plate sets.

4.1.4 The following test plates have been designed (dimensions in inches):

A. The Main adapter plate illustrated in Drawing 1 is used to allow the Test Plate Sets (described in B below) to be mounted to the shielded room wall is 0.500 inch thick. The outer bolt pattern of this plate mates with the bolt pattern on the shielded room. The inner bolt pattern accepts the Test Plate Sets.

B. The Test Plate Sets are made up of two aluminum plates. The first plate (frame) illustrated in Drawing 2 is designed with a cutout in the center and two outer bolt patters and is 0.250 inch thick. One set of bolt holes is for the hardware necessary to mount the set to the main adapter plate (described in A above). The second set of holes accepts that hardware to bolt the set together including the cover plate (described in C below).

C. The cover plate illustrated in Drawing 3 is also made of aluminum and is 0.250 inch thick. This plate makes up the second half of the Test Set. The outer bolt pattern allows for the cover to be bolted to the frame.

The gasket and flange treatment (or "test set") is designed so that the shielding effectiveness measurements and environmental exposure can be done without disassembly of the "test 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) shim stock, of proper thickness as illustrated in Drawing 4.

Metal fasteners (bolts) are used in all cases. The fasteners used to bolt the plate sets to the shielded room wall are electrically isolated from the aluminum cover plate due to the hole diameters so that no additional conductive path is introduced across the gasket interface under test. Fastener selection should be made to ensure this.

4.2 Sample Gasket Preparation

4.2.1 This test method was initially developed using a solid "D" conductive elastomer gasket with a width of 0.175 inch and a height of 0.178 inch. The solid "D" 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, FIP gaskets can be tested by dispensing directly on one of the Test Plates.

4.2.2 The gasket configuration (not cross-section) is a square "picture frame" which has outside dimensions adequate to fit inside the bolt pattern of the cover plate and maintain separation from the compression stop (shims) being incorporated. Fitting gaskets into the corners can be handled in a number of ways. The preferred method is to use one piece of gasket material and "butt" the ends together. Alternatively, the gasket can be assembled from four strips cut at a 45 degree angle, with corners either butted together or spliced with a conductive compound.

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 shims illustrated in Drawing 4 of different thicknesses.

4.3 The EMI test chamber must meet or exceed the following specifications:

Minimum size: 16 feet long x 12 feet wide x 8 feet high. The use of either stirred mode or anechoic chambers is acceptable, although not required. Figure 1 is an example of a shielded enclosure designed with two sides opposite an isolation wall.

Attenuation tests must demonstrate that the shielded enclosure meets attenuation requirements in excess of 100dB from 20MHz to 10GHz.

The available AC power within the shielded enclosure is 115V AC, single phase, 60 cycle or 230V AC, single phase, 50 cycle for the test equipment operation. This power is required to be provided through line filters rated at 100 dB of attenuation from 10 kHz to 10 GHz.

Any unused aperture in the shielded enclosure should be covered with blank panels of aluminum or steel plate using metal fasteners, appropriate gaskets and copper foil tape. The technique used must ensure that no leakage from such panels will affect measurements made on the test gaskets.

4.4 Support equipment, such as amplifiers, signal generators, and transmitting antennas should be located on one side of the shielded enclosure opening. The spectrum analyzer and receive antenna are located on the other side of the shielded enclosure opening. The transmitting and receiving antenna distances should be 1 meter from the test plate on each side (2 meters plus the thickness of the test panel apart).

4.5 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, their location within the test setup and value will be noted on the test data sheet and within the test report.

5.0 SHIELDING EFFECTIVENESS MEASUREMENTS

5.1 Each gasket material Test Set to be tested should be mounted (one at a time) on to the adapter plate 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 (see Figure 4).

5.2 The test should be performed at frequencies of 20 MHz, 40 MHz, 60 MHz, 80 MHz, 100 MHz, 200 MHz, 400 MHz, 600 MHz, 800 MHz, 1 GHz, 2 GHz, 4 GHz, 6 GHz, 8 GHz, and 10 GHz. Extension of the frequency range above and/or below what is specified is acceptable.

Swept frequency test techniques are acceptable.

The type of field (i.e., electric or plane wave), and the antenna polarization, should be noted on the test data sheet for each frequency under investigation.

5.3 Due to the symmetrical nature of the test setup and fixtures, only one antenna polarization is required during testing.

Receive and Transmit antenna polarizations shall match.

5.4 Shielding effectiveness values are obtained based on the initial open reference measurement. The reference shall be taken as follows:

Open reference signal measurement is to be performed by transmitting through the 12 inch x 12 inch opening, with the antennas located in the same position as the final testing, but with no cover plate or plate set over the open aperture. This "through hole" reference measurement technique is in accordance with the requirements of MIL-DTL-83528C (see Figure 2).

5.5 Final signal measurements with the gasketed panel in place are to be performed as illustrated on Figure 3.

5.6 The shielding effectiveness is calculated by taking the power level recorded during the reference measurement, and subtracting from it the power level recorded during measurements made with the gasketed plate set covering the aperture. Below is a sample calculation.

5.7 Reference-Gasket = Shielding Effectiveness
Level Level
+10 dBm - (-102 dBm) = 112 dB

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 the location and time of the 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)	8566B	Spectrum Analyzer
Agilent (Hewlett Packard)	85685A	RF Preselector
Agilent (Hewlett Packard)	8341B	Signal Generator
Amplifier Research	150L	Amplifier
Amplifier Research	30W1000M7	Amplifier
Agilent	4440A	Spectrum Analyzer
Agilent (Hewlett Packard)	8672A	Signal Generator
EMCO (Qty 2)	3115	Horn Antenna
EMCO (Qty 2)	3109	Biconical Antenna
Singer (Qty 2)	CLS-105A	Log Spiral Antenna
ENI	603L	RF Amplifier
RF Power Labs	220-IK60L	RF Amplifier
Logimetrics	A300L	TWT RF Amplifier
Logimetrics	300U	TWT RF Amplifier
Logimetrics	A300/S-08	TWT RF Amplifier
Logimetrics	300/C-08	TWT RF Amplifier
Narda	768-20	Attenuator

TABLE 1

SHIELDING EFFECTIVENESS TEST DATA

CUSTOMER: ______________________ **DATE:** ______________________

EQUIPMENT: ______________________ **TEST NUMBER:** ______________________

TESTED BY: ______________________ **TEST SPEC:** ______________________

R & D REFERENCE: ______________________

TYPE OF FIELD	FREQUENCY MHz	ANTENNA POLARIZATION	OPEN REFERENCE dBm	CLOSED dBm	SHIELDING EFFECTIVENESS dB	LIMIT	REMARKS

Test Equipment (Model and Serial Number):

____

____

FORM CTSDS020

TABLE 2

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

Chomerics Shielding Effectiveness
Shielded Room

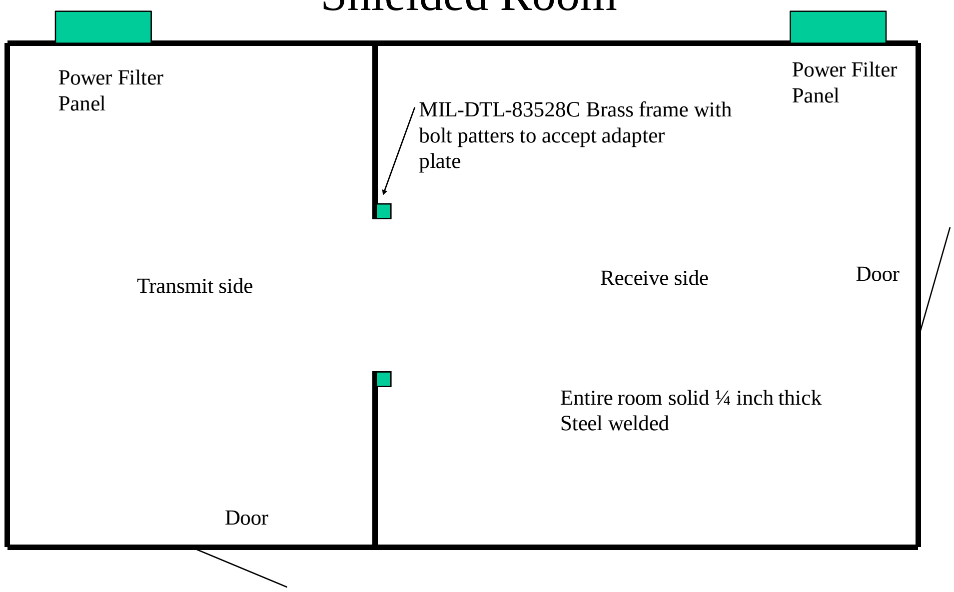


Figure 1

Shielding Effectiveness Test Setup
Open Reference

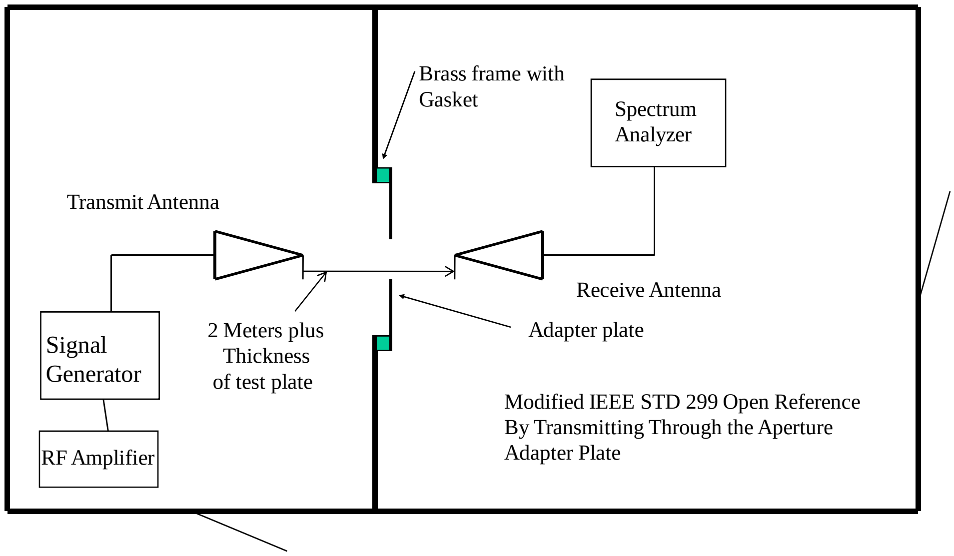


Figure 2

Shielding Effectiveness Test Setup
Final Measurements

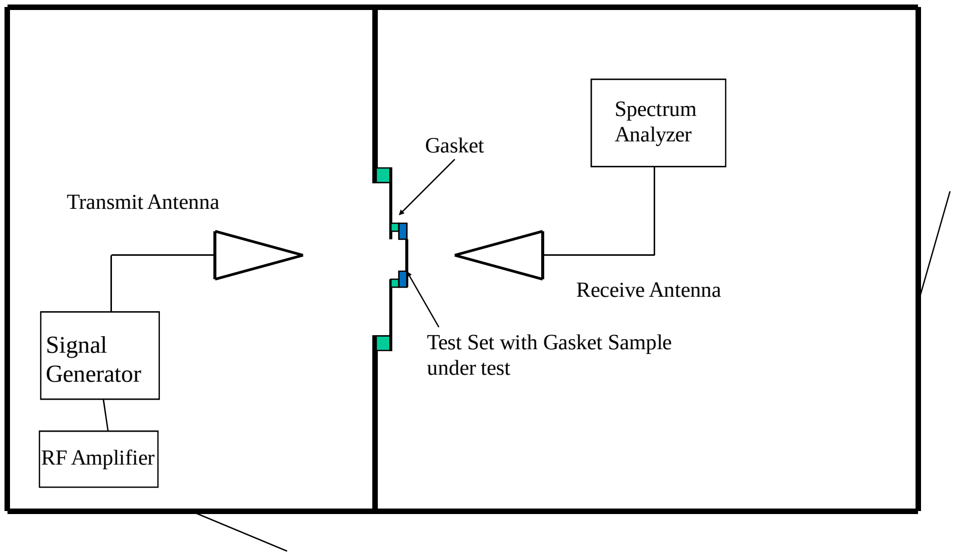


Figure 3

Test Plate Setup
Cross Section

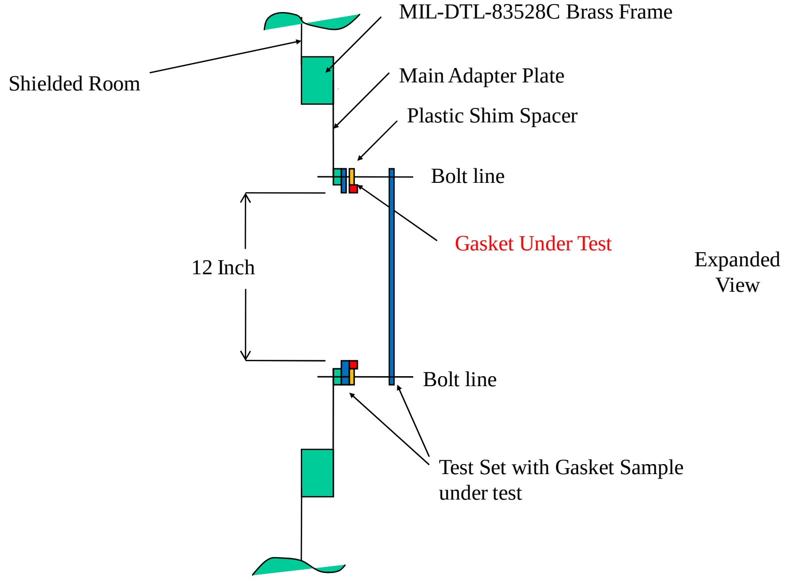
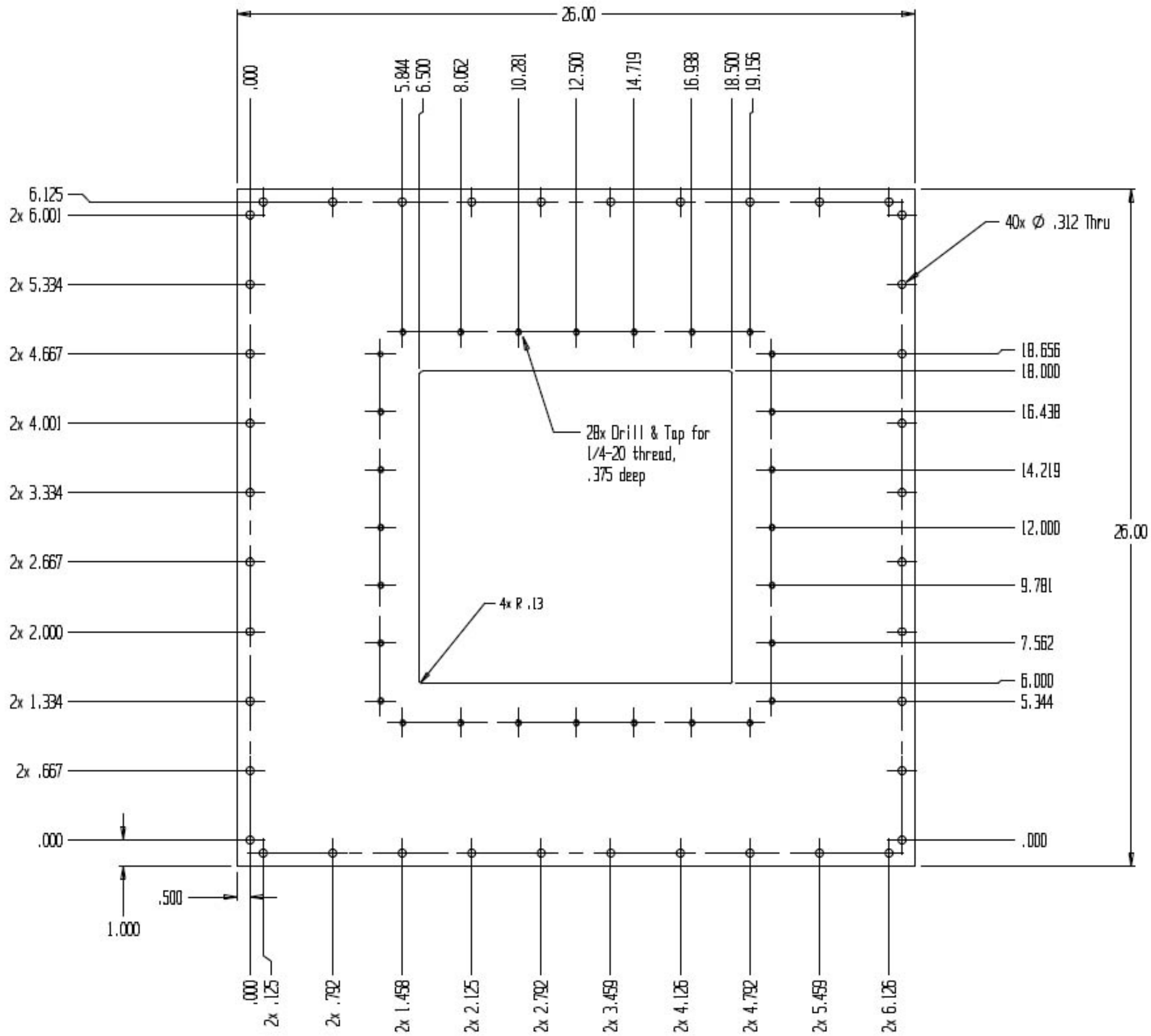


Figure 4



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2x 2.667
2x 2.000
2x 1.334
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16.438
14.219
12.000
9.781
7.562
6.000
5.344
.000
26.00
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.375 deep
4x R .13
.500
1.000
.000
2x .125
2x .792
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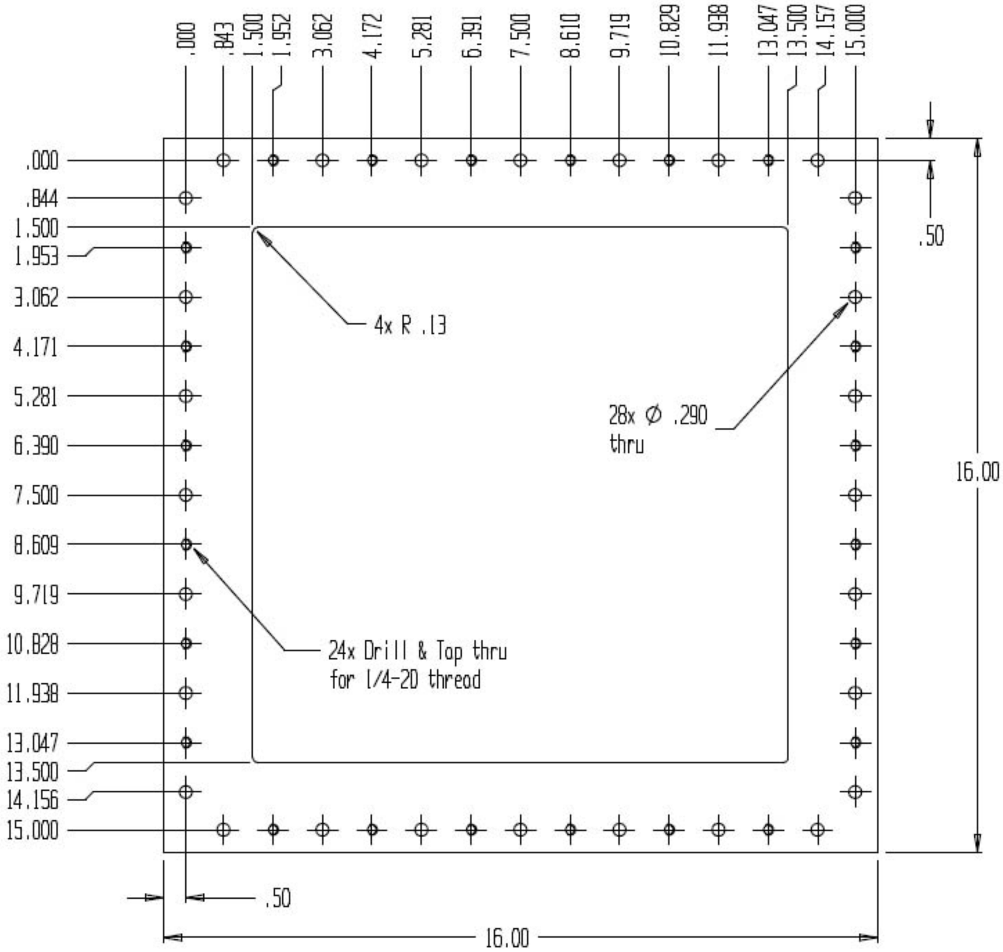
Drawing 1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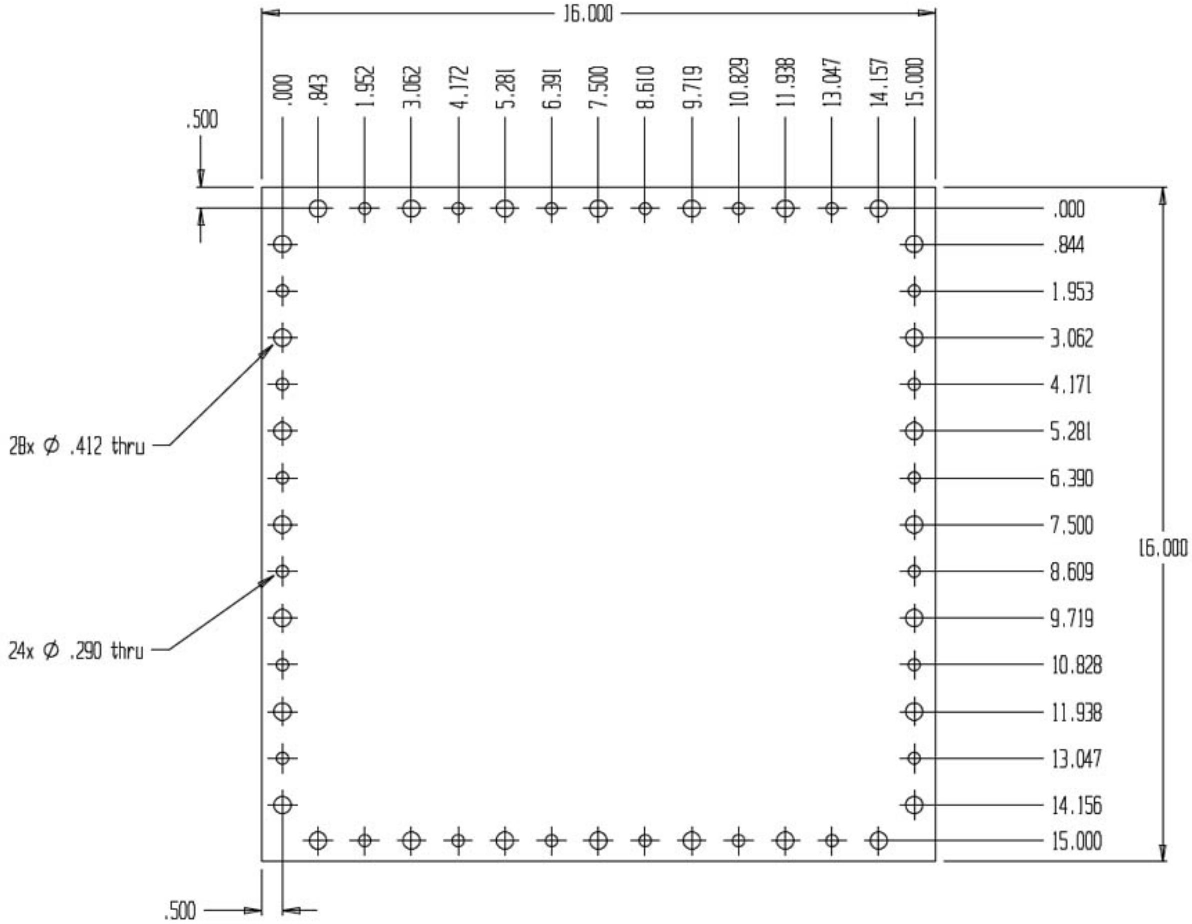
Drawing 2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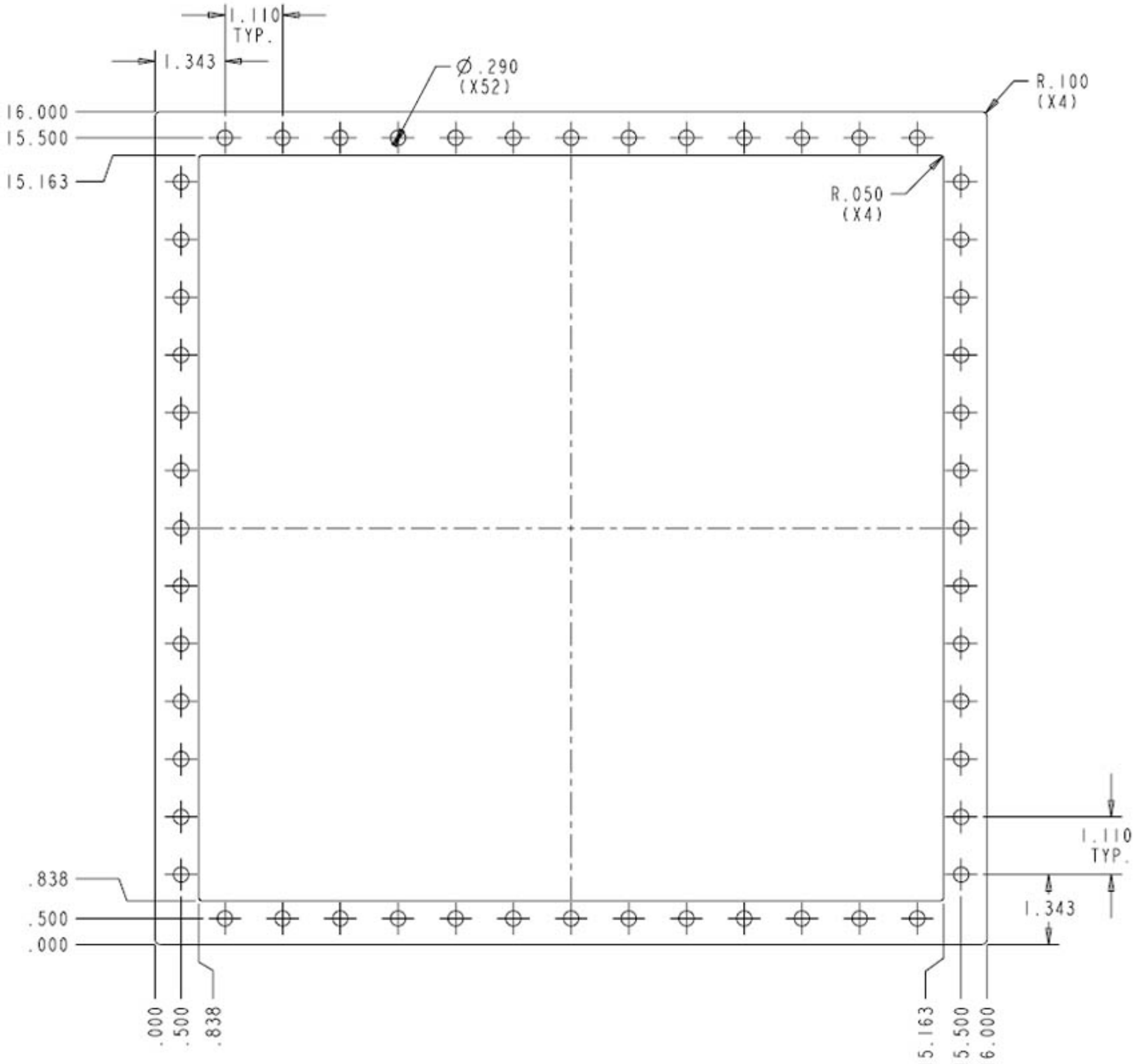
Drawing 3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TYP.
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15.500
16.000

Drawing 4