AN1583

Motorola's Next Generation Piston Fit Pressure Sensor Packages

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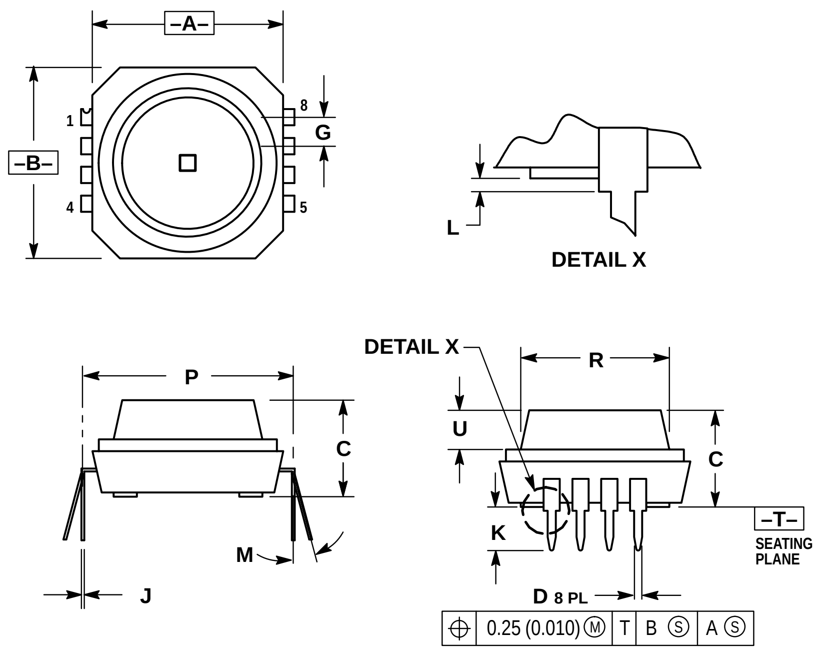
Motorola has introduced a new line of pressure sensor packages to satisfy the requirements of many of our customers. The advent of the silicon based pressure sensor has created a wide variety of new systems design approaches which were previously unavailable. More and more pressure sensor customers want to integrate silicon pressure sensors into their systems to provide not just measurement capabilities but also to provide information or feedback for a control loop. In addition, the low cost of silicon based pressure sensors has made it affordable and possible to incorporate pressure sensing into many more products. Of concern with these products is that the assembly costs be kept to a minimum. The 'next generation' piston fit packages were designed with this in mind. An additional concern when assembling a pressure sensor into a system is that a leak proof seal is obtained so that accurate pressure readings may be made and no loss of the system fluid is allowed. Also, the installation of the pressure sensor within the system should not affect the sensor's accuracy or output.

Motorola's new piston fit packages come in three different types — the top side piston fit, the dual piston fit and the backside piston fit, as shown in Figures 1 thru 3. These piston fit packages were designed to be installed into a customers housing using a standard O–ring to obtain a leak proof seal. The O–ring fits over the outside of the piston fit package like a piston ring fits over the outside of a piston. Hence the name — piston fit packages. The external geometry of the top side piston fit (TPF) and the back side piston fit (BPF) packages is the same. The differences between the packages are internal. The main difference is that for the TPF the piston fit is on the top side of the sensor die and on the BPF the piston fit is on the backside of the pressure die. The BPF is to be used mainly for vacuum measurement, where the vacuum is applied to the back side of the die, or for pressure sensors that use a backside pressure exposure for media compatibility as with the MPX906 series pressure sensors. The dual piston fit (DPF) package is designed for use in differential or gage pressure applications where two unknown pressures or an unknown pressure and local atmospheric pressure are applied to either side of the sensor die. The TPF is to be used for absolute or gage pressure measurements.

A silicon based pressure sensor is essentially a strain gage. It is designed to measure the strain in the silicon diaphragm or die when that diaphragm has a pressure applied to it. The higher the pressure difference across the diaphragm, the more the diaphragm deflects and, therefore, the larger the strain that is measured. If an external strain is applied directly to the die through the package or through thermal growth differences in the assembly, the sensor will have a shift in the output voltage even though there is no change in the pressures applied to the die. To minimize this phenomenon, the piston fit packages were designed to be very robust and to isolate the die from externally applied strains. An epoxy thermo–set plastic was chosen as the material for the piston fit package. This material offers high strength, good thermal stability and low moisture absorption — all important features to the operation of the device. The use of the piston fit package with an o–ring(s) further helps to isolate the package and the sensor die from system level stresses and strains that can be applied to the package. In addition, the o–ring allows for differences in the thermal growth of the assembled system while minimizing any transfer of stress or strain to the package. This means that if the housing that the sensor is assembled in is hotter than the sensor or grows due to temperature at a different rate than the sensor, the o–ring will accommodate these differences without passing the strain into the package.

O–RING SELECTION

The piston fit packages were designed to be used with standard o–rings. For the cavity geometries provided in Figures 5 thru 10, the standard o–ring size is 1/2″ ID x 5/8″ OD x 1/16″ cross section diameter. See Figure 4. Most o–ring manufacturers use a universal number system to specify o–ring size and type. These numbers can contain prefixes and suffixes that will indicate material types, tolerance class, durometer of the o–ring material (hardness of the elastomer), and application (static seal, dynamic seal, etc.). The universal dash number is typically the same between manufacturers. The dash number for the recommended o–ring for the piston fit packages is –014. When selecting an o–ring material the hardness of the material as well as the chemical resistance should be taken into account. An o–ring material should be compatible with the media it may come in contact with and should be as soft as possible to minimize stress or strain transfer from the system to the pressure sensor package and to maximize sealing. A softer material (lower durometer number) will flow into micro scratches and grooves in the mating parts more easily. For dry air, a good o–ring selection is a Parker Seal's P/N 2–014 S469–40. This is a silicon o–ring with a durometer of 40.



NOTES:

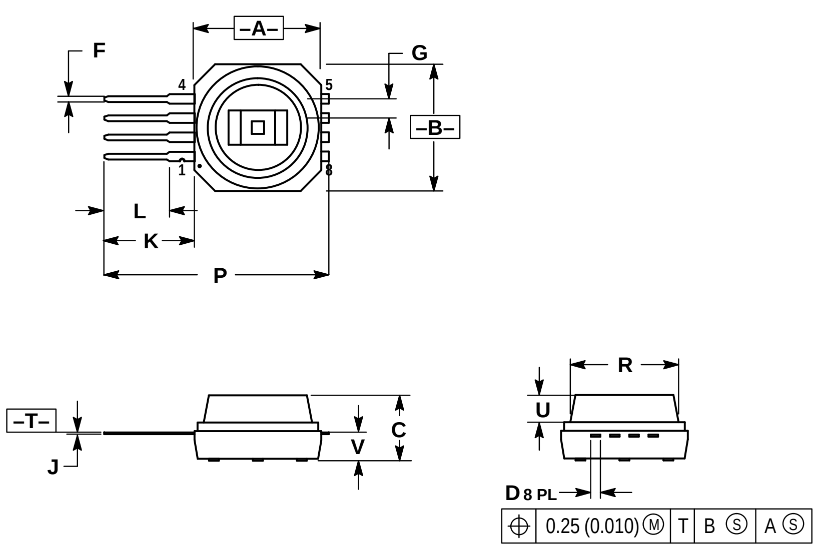
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006).
5. ALL VERTICAL SURFACES 5°TYPICAL DRAFT.
6. DIMENSION P TO CENTER OF LEAD WHEN FORMED PARALLEL.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.658	0.668	16.71	16.97
B	0.658	0.668	16.71	16.97
C	0.329	0.357	8.36	9.07
D	0.026	0.034	0.660	0.864
G	0.100 BSC		2.54 BSC	
J	0.009	0.011	0.23	0.28
K	0.138	0.150	3.81	3.51
L	0.002	0.020	0.05	0.51
M	0°	15°	0°	15°
P	0.738	0.748	18.75	19.00
R	0.503	0.523	12.78	13.28
U	0.135	0.145	3.43	3.68

STYLE 1:
PIN 1. NC
2. VSUPPLY
3. GROUND
4. VOUT
5. NC
6. NC
7. NC
8. NC

STYLE 2:
PIN 1. GROUND
2. +VOUT
3. VSUPPLY
4. –VOUT
5. NC
6. NC
7. NC
8. NC

Figure 1. Top Piston Fit Package with 84° Lead Form



NOTES:

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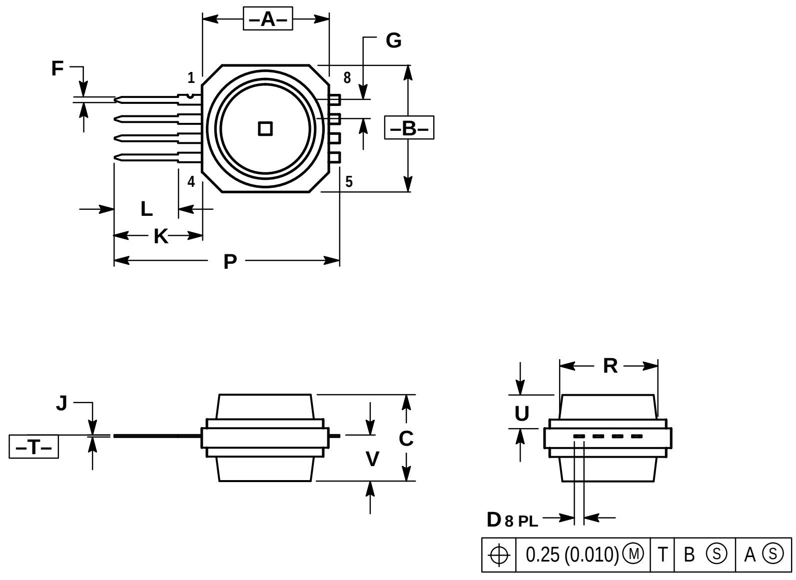
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006).
5. VERTICAL SURFACES MAY BE UP TO 5° DRAFT.
6. DATUM –T– IS PARTING LINE PLANE.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.658	0.668	16.71	16.97
B	0.658	0.668	16.71	16.97
C	0.327	0.337	8.30	8.56
D	0.046	0.054	1.17	1.37
F	0.026	0.034	0.660	0.864
G	0.100 BSC		2.54 BSC	
J	0.009	0.011	0.23	0.28
K	0.463	0.473	11.76	12.01
L	0.320	0.332	8.13	8.43
P	1.155	1.187	29.34	30.15
R	0.503	0.523	12.78	13.28
U	0.135	0.145	3.43	3.68
V	0.107	0.117	2.72	2.97

Figure 2. Backside Piston Fit Package with Straight 4–Lead, Lead Form



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006).
5. VERTICAL SURFACES 5° TYPICAL DRAFT.
6. DATUM –T– IS PARTING LINE PLANE.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.658	0.668	16.71	16.97
B	0.658	0.668	16.71	16.97
C	0.455	0.465	11.56	11.81
D	0.046	0.054	1.17	1.37
F	0.026	0.034	0.660	0.864
G	0.100 BSC		2.54 BSC	
J	0.009	0.011	0.23	0.28
K	0.463	0.473	11.76	12.01
L	0.320	0.332	8.13	8.43
P	1.155	1.187	29.34	30.15
R	0.503	0.523	12.78	13.28
U	0.135	0.145	3.43	3.68
V	0.235	0.245	5.97	6.22

STYLE 1:
PIN 1. NC
2. VSUPPLY
3. GROUND
4. VOUT
5. NC
6. NC
7. NC
8. NC

STYLE 2:
PIN 1. GROUND
2. +VOUT
3. VSUPPLY
4. –VOUT
5. NC
6. NC
7. NC
8. NC

Figure 3. Dual Piston Fit Package with Straight 4–Lead, Lead Form

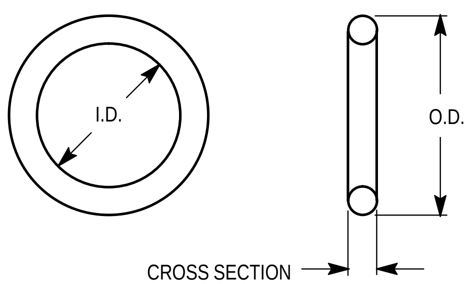


Figure 4. O–ring Geometry

PISTON AND CAVITY GEOMETRIES

The Piston Fit family of packages are available in a variety of lead form options. These options include 8–lead 84° lead form, straight 8–lead and 4–lead forms. The various lead forms need to be taken into account when designing a housing to enclose the sensor package. Figures 5 and 6 show how the dual piston fit package can be incorporated into a housing. Notice that in this particular example, the 84° 8–lead package option has been used. Figures 7 and 8 show a top side piston fit package with an 8–lead 84° lead form incorporated into a custom housing. Figures 9 thru 11 show the geometries used for the cavities that the sensor packages fit into. The top piston and the backside piston geometries for all three sensor packages are identical. Figure 11 shows the geometry for the cavity that will enclose the flat side of a TPF or BPF package.

Notice that these packages have four small circular bosses that need to have relief provided for. In this design, two of the bosses have a matching relief cavity in the housing while a cut out in the housing provides the clearance for the other two bosses. For an absolute pressure sensor in the TPF or BPF package, no pressure port is required on the flat side of the package. For a gage application, a pressure port or hole is required to allow ambient pressure to the sensor package. It should also be noted that clearance should be provided around the lead forms to prevent possible shorts across leads.

OPTIONAL MOUNTING METHODS

While the piston fit family of packages were designed to be used with an o–ring to provide sealing and ease of installation, other methods of mounting the devices can be done successfully. One such method is to use an adhesive compatible with the epoxy sensor package and whatever material that the housing is to be made from. These adhesives can be epoxy based or RTV based materials. When using epoxy materials, some consideration for the differences in the coefficients of thermal expansion between the different sensor, housing and adhesive materials should be made. The different rates of thermal expansion can create large thermal stresses in the assembly which can cause cracking and leaks in the assembly and can also cause shifts in the sensor output. RTV adhesive materials are generally lower in stiffness and act to reduce the transfer of stresses to the sensor. Because of this lower stiffness, RTV materials are not very good as a part of a rigid structural path. In other words, the RTV adhesive should be used in systems where there is no load applied to the RTV. This could include a system where the sensor is enclosed by a housing such as that shown in Figures 5 and 7.

CONCLUSION

The piston fit family of packages have been designed to meet customer needs and to be used in conjunction with a customer designed housing. This package is designed to be easily installed using standard O–rings. This package offers increased stress isolation for the sensing die and ease of installation. It is also possible to mount the package using adhesives to glue the sensor to a housing. This package was designed to compliment the existing family of ported and unported unibody pressure sensor packages. This package affords the customer the flexibility to easily add the sensor to a system design by incorporating some cavities into their system housing.

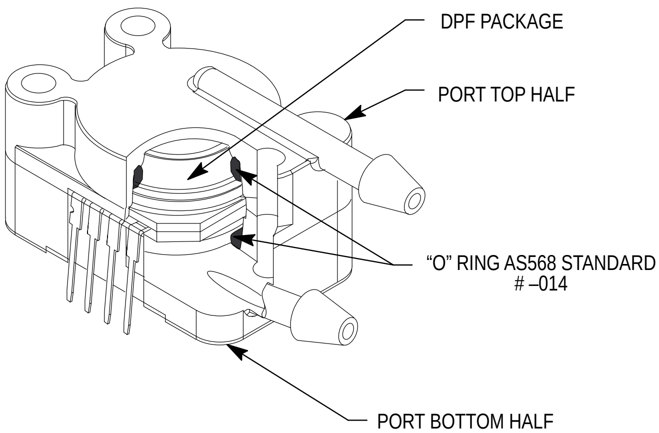


Figure 5. Dual Piston Fit Package Custom Housing

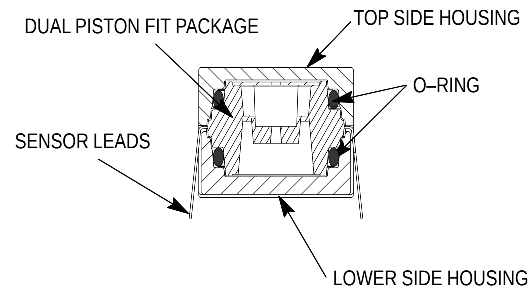


Figure 6. Dual Piston Fit Custom Housing Cross Section

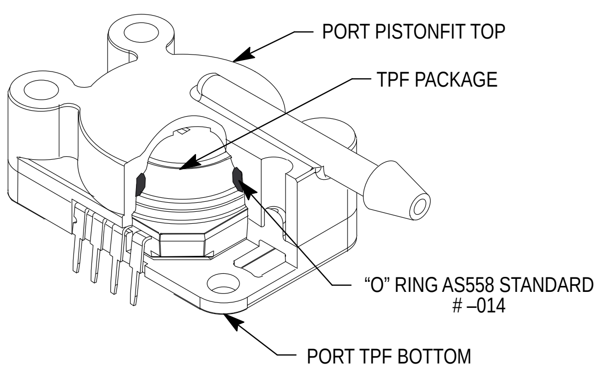


Figure 7. Top Side Piston Fit Custom Housing

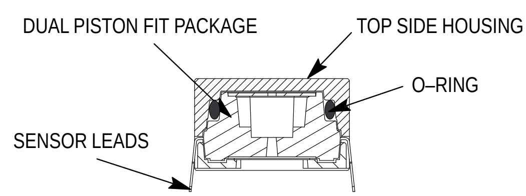


Figure 8. Top Side Piston Fit Custom Housing Cross Section

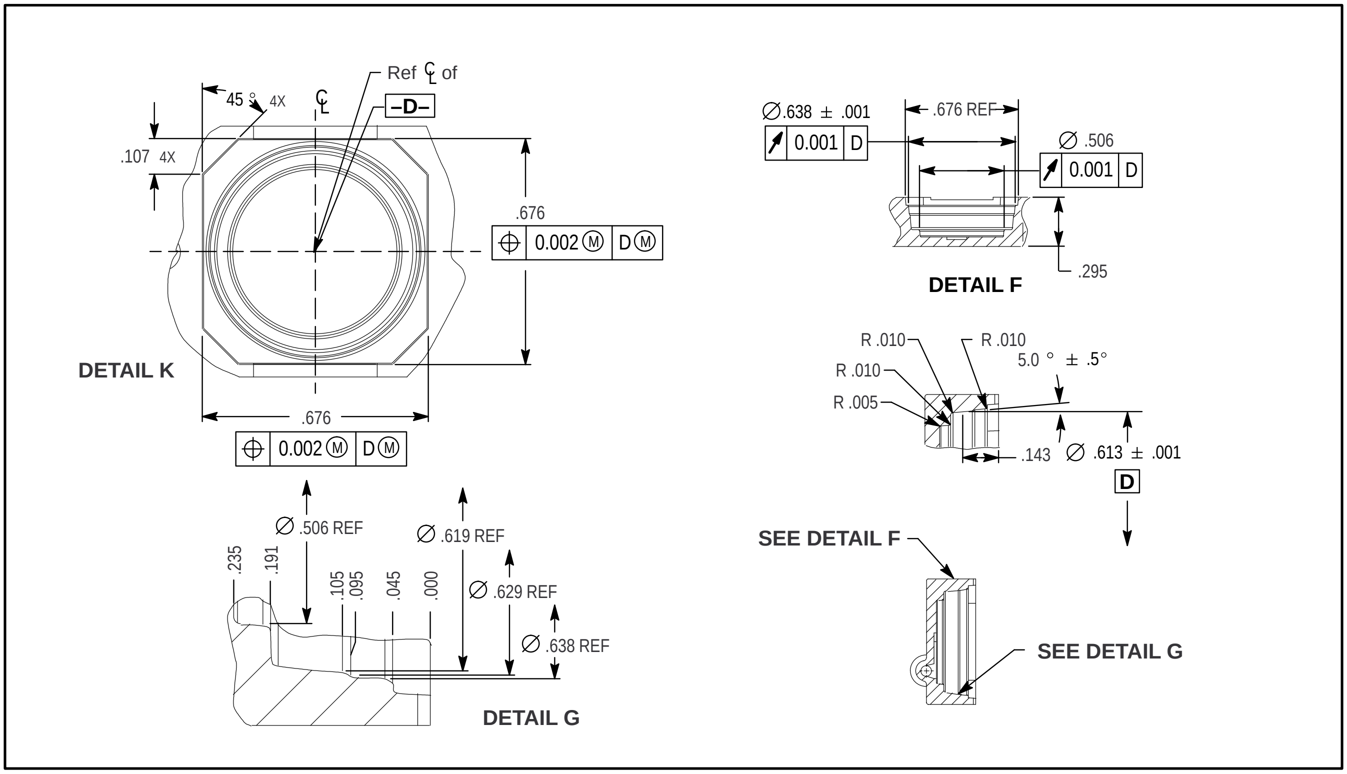


Figure 9. Top Cavity Geometry

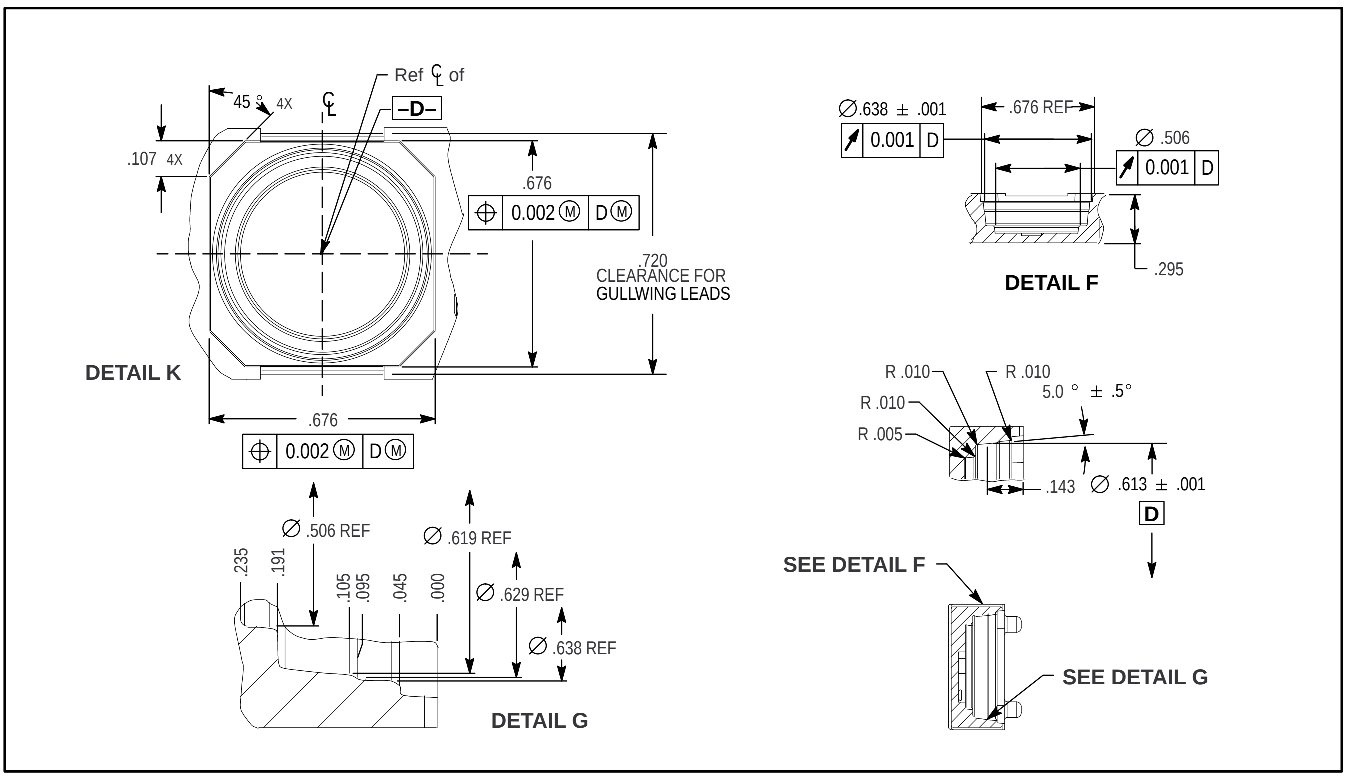


Figure 10. Dual Piston Fit Bottom Cavity Geometry

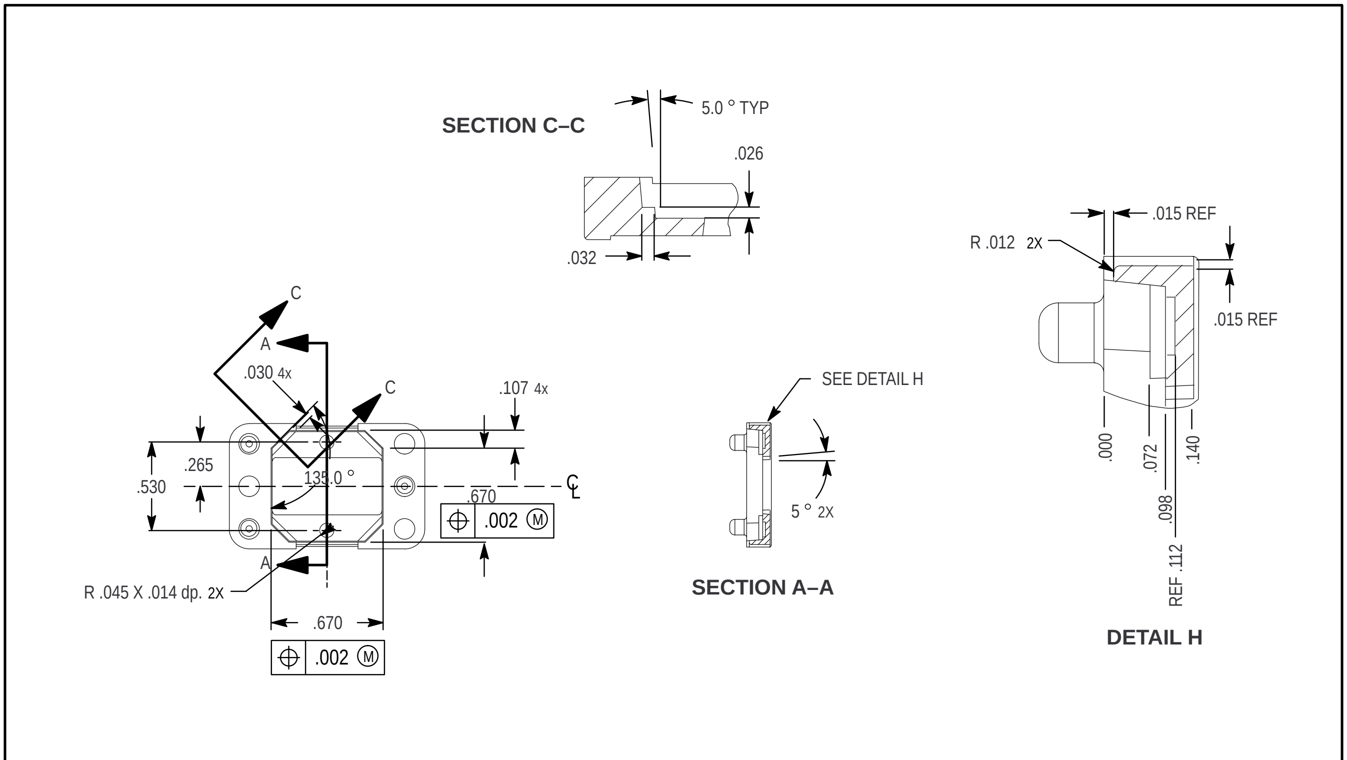


Figure 11. Top Side Piston Fit Bottom Cavity Geometry

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