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## Application Bulletin: #158C

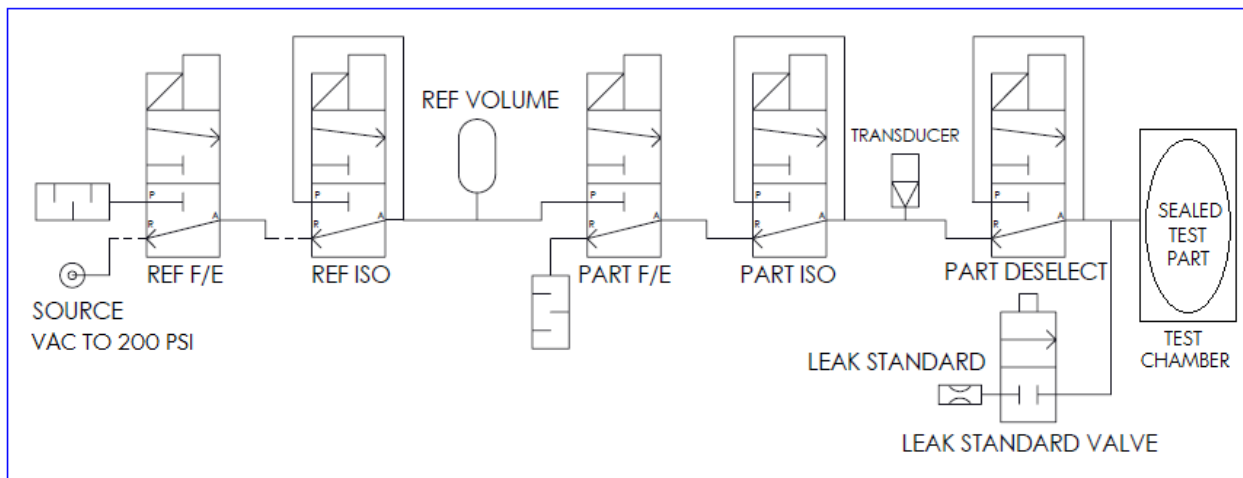
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# TESTING SEALED PARTS: FIXED VOLUME FILL TESTING - I28

**Application:** Sealed parts with no charge ports must be tested in a chamber that can be either pressurized or **evacuated** to create a differential pressure across the part wall. A sealed part with a severe leak cannot be tested for fine leaks because it is charged with pressure/**evacuated** with its Test Chamber. Therefore, no pressure differential is created across the part wall when the test is performed.

**Solution:** Because there is no way to introduce air into/**evacuate air from**, a sealed part, the part must be tested in a leak-tight chamber with minimal volume around the part. The amount of volume in the chamber influences the test cycle time and the sensitivity of the leak test. To optimize both cycle time and sensitivity, it is best to use a chamber that is custom-formed to the part.

If the part has a large leak, air will quickly enter the part during the Test Chamber fill cycle. To detect a severe leak condition, the amount of air charged into, or pulled out of, the chamber must be controlled. The test must then detect whether any air is passing quickly through the part wall. To control that volume of fill air/**evacuated air**, a fixed volume fill test circuit is recommended. The following pneumatic diagram shows the fixed volume fill test circuit used in the I28 volumetric fill manifold.



**Concept 1:** When the test begins, the Reference Volume is pressurized/**evacuated** to a pressure/**vacuum** greater than the desired differential pressure across the test-part wall. The Reference Volume is isolated from the source and the Reference Volume and the Test Chamber are connected. The ratio of the Test Volume (Chamber volume minus Sealed Test Part volume) to the Reference Volume determines the required charge pressure for the Reference Volume. For example, if the Reference Volume were equal in size to the Test Volume, then the charge pressure for the Reference Volume will be two times the final desired resultant Test Chamber pressure.

### I28 Volume Test Sequence:

1. Fill Ref cycle. The Part Fill/Exhaust valve (**PART F/E**) energizes, the Part Deselect valve energizes, and the Reference Fill valve (**REF F/E**) energizes so that the Reference Volume is pressurized/**evacuated** to the Initial Pressure and the pressure transducer can measure the Initial Pressure.
2. Stab Ref cycle. The Reference Isolation valve (**REF ISO**) energizes to close and the Initial Pressure in the Reference Volume stabilizes.
3. Test cycle. The Part Deselect valve de-energizes to open and pressurize/**evacuate** the Test Chamber using the fixed volume of air/**vacuum** in the Reference Volume. The pressure between the Volumetric Fill Reservoir and the Test Chamber minus Part volume equalizes. *Adequate time in the Test cycle is critical to achieve an accurate volume measurement.*

The volume test result is calculated using the following formula:

$$\%V_{ref} = \frac{V_T}{V_R} = \frac{(P_1 - P_2)}{P_2}$$

Where:

$P_1$  = Initial Pressure of the Reference Volume

$V_R$  = Reference Volume

$P_2$  = Equilibrium pressure in the Test Chamber after the Part Fill/Exhaust valve is opened

$V_T$  = Test Volume (Test Chamber volume – Sealed Test Part volume)

**Note:** The volume test does not provide an actual volume measurement. Instead it uses pressure measurements to provide a ratio of the Test Chamber volume as compared to the reference volume. Thus the evaluation and limit variables are shown as percentage of the reference volume [%  $V_{ref}$ ].

4. The Volume test result, %  $V_{ref}$ , is compared to the settings for Low Limit %  $V_{ref}$  and High Limit %  $V_{ref}$ . The test evaluation is selected from one of the 6 following options: F/P/F, F/F/P, P/F/P, F/P/P, P/F/F, P/P/F. Based on the settings, the test result is either Accept or Reject.

**Note:** All setup testing should be performed using a leak free master part in the Test Chamber. When setting the %  $V_{ref}$  High limit, it is helpful to test a part that has a large hole (severe leak). The resulting Volume test result for this condition must fail the %  $V_{ref}$  High limit.

**Concept 2:** An additional test type that combines a Volume test with a Pressure Decay/Leak Standard test is possible if the I28 instrument was purchased with this capability. A leak standard is required to calibrate the Test Volume with a leak free master part. An alternative to running this combination test type is to use a Parent Linking program to run a Volume test then link to: a Pressure Decay  $\Delta P$  test, a Pressure Decay  $\Delta P/\Delta T$  test, or a Pressure Decay-Leak Standard test.

### **I28 Volume Test and Pressure Decay Leak Standard Test Sequence:**

1. Fill Ref cycle. The Part Fill/Exhaust valve (**PART F/E**) energizes, the Part Deselect valve energizes, and the Reference Fill valve (**REF F/E**) energizes so that the Reference Volume is pressurized/**evacuated** to the Initial Pressure and the pressure transducer can measure the Initial Pressure.
2. Stab Ref cycle. The Reference Isolation valve (**REF ISO**) energizes to close and the Initial Pressure in the Reference Volume stabilizes.
3. Test cycle. The Part Deselect valve de-energizes to open and pressurize/**evacuate** the Test Chamber using the fixed volume of air/**vacuum** in the Reference Volume. The pressure between the Volumetric Fill Reservoir and the Test Chamber minus Part volume equalizes. *Adequate time in the Test cycle is critical to achieve an accurate volume measurement.*

The volume test result is calculated using the following formula:

$$\%V_{ref} = \frac{V_T}{V_R} = \frac{(P_1 - P_2)}{P_2}$$

Where:

$P_1$  = Initial Pressure of the Reference Volume

$V_R$  = Reference Volume

$P_2$  = Equilibrium pressure in the Test Chamber after the Part Fill/Exhaust valve is opened

$V_T$  = Test Volume (Test Chamber volume – Sealed Test Part volume)

4. The Volume test result,  $\%V_{ref}$ , is compared to the settings for Low Limit  $\%V_{ref}$  and High Limit  $\%V_{ref}$ . The test evaluation is selected from one of the 6 following options: F/P/F, F/F/P, P/F/P, F/P/P, P/F/F, P/P/F. Based on the settings, the test result is either Pass or Fail.
5. Stabilize cycle. The Part Isolation valve energizes to close and the Equilibrium pressure in the Test Chamber stabilizes.
6. Test 2 cycle. The I28 instrument performs the pressure decay leak test (calibrated with a leak standard) to determine the leak rate of the Sealed Test Part. The pressure decay leak test result is compared to the settings for Low Limit Leak and High Limit Leak. The test evaluation is selected from one of the 6 following options: F/P/F, F/F/P, P/F/P, F/P/P, P/F/F, P/P/F. Based on the settings, the test result is either Pass or Fail.
7. A final determination of Accept or Reject is made based on the combination of the two test evaluations. If both tests result in a Pass condition, the final test result is Accept. However, if either of the tests result in a Fail condition, the final test result is Reject.

**Note:** In order to provide accurate volume ratio, it is important that enough time is allowed for the reference volume and chamber volume to equalize and measure the combined volume pressure during the volume test timer. Premature timers can cause inaccurate volume estimations.