Sprint iQ

Owner's Guide

Uson

Due to a program of continual improvement, Uson reserves the right to modify or otherwise change specifications and/or tester performance without notice. Uson has made every attempt to completely describe the operation of the tester. Uson shall not be liable for technical or editorial errors or omissions.

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1.1 Safety Considerations

Electrical and pneumatic (or air pressure) hazards are the two primary areas of concern when operating leak-testing equipment.

If the equipment is used in a manner not specified in this manual, the protection provided by the equipment may be impaired.

1.1.1 Pneumatic Hazards

Always wear eye protection when working with pressurized air. Disconnect all pressure sources when working with internal components of Uson equipment.

1.1.1.1 Fixture Considerations

Fixture safety considerations vary depending on the fixture being leak tested.[1] However, the following hazards of working with pressurized systems should be given serious consideration before operating the Sprint iQ:

- High-pressure pneumatic air systems are exponentially more hazardous as the pressure increases, or as the volume of a system increases. Testing equipment subjected to consistently high-pressure ranges has an

1.Jackson, Charles N., Jr., Sherlock, Charles N., technical editors, and Moore, Patrick O., editor. "Safety Aspects of Leak Testing." Nondestructive Testing Handbook, third edition: Vol. 1, Leak Testing. Columbus, OH: American Society for Nondestructive Testing (1998): p 136.

increased probability of becoming unable to permanently resist the effects of such pressure.

- Observe caution when working with nonreactive gases or liquids above their boiling points (even at lower pressures), especially when larger volumes of gases are involved. It is essential that relief valves, rupture disks, and pressure regulators are employed to ensure safety.
- Even at moderate pressures, pressurized systems can present a hazard in the form of pressurized air escaping from a leak or a failure. The hazard of flying particles is added when a sight glass or glass flow meter is introduced to the system. The sudden burst of a part could generate sufficient sound concussion to cause hearing damage.

1.1.2 Electrical Hazards

Always exercise caution when working with electricity.

Always use a replacement fuse of the same type and rating as the original. Failure to do so may be hazardous and can cause damage to the equipment.

1.1.3 General Safety Issues

Perform operations, maintenance, or troubleshooting procedures only after reading and comprehending all manuals and materials supplied with the Sprint iQ.

2.1 FAST-TRACK SETUP

Connect clean, dry supply air.

Connect peripheral devices, if any.

Connect the power supply and turn on Sprint iQ. Turn the connector's collar until it is finger-tight to ensure a good connection.

Use the back panel switch to turn on the Sprint iQ.

Turn the Lockout Keyswitch to the *program* position (horizontal).

Set the units of measure to use for pressure, flow volume, and flow time.

Enter test parameters for the first program to run.

Enter test parameters for additional programs if you are using more than one program.

Set communication values for the connected peripherals, if used.

Turn the Lockout Keyswitch to *run* position (vertical). Sprint iQ is now ready to use.

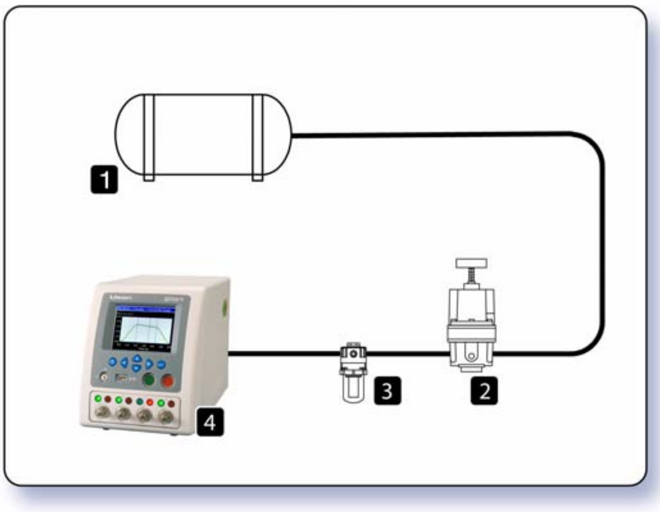
Do not allow the power supply's ventilation slots to be blocked. The power supply has an automatic fan that runs as necessary to prevent overheating.

2.1.1 Sprint iQ Requires Clean Dry Air

Before connecting air (or other gas) to Sprint iQ, make certain the supply air is clean and dry and pressure doesn't exceed the maximum input listed on the rear panel.

Water vapor, particulates, and excessive pressure can damage Sprint iQ's internal components and affect product testing

Supply air is connected to the 1/8-inch female NPT bulkhead on the back of Sprint iQ.



1 Compressor

2 Step-down regulator

3 Mist and Particulate Filter

4 Sprint iQ

2.2 Front Panel Features

The front panel has an LCD display, keypad, Lockout keyswitch, USB port, and **Stop** and **Start** buttons.

1 **Display**. The Sprint iQ has a 5.7" diagonal 320 x 240 color graphic liquid crystal display (LCD) with backlight.

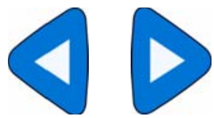
2 **Keypad**. The keypad has 6 keys:

- **Exit**. Use the **Exit** key to exit the Run Mode Options Menu mode and return to the Run display. It is also an "escape" key, allowing parameter entry to be aborted without saving changes.

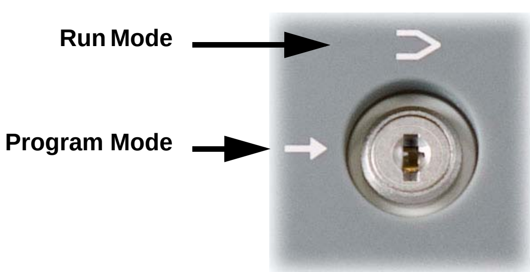
- **Enter**. Use the Enter key to select the chosen item. This key is also used to save a value that has been entered. This may be a highlighted item or an entry. If it is not desired to save an entry, use the **Exit** key instead.

- **Increment** and **Decrement** (**Up** and **Down**). These keys are used to move up and down. They are most often used when moving through the Test Parameters screen. These keys will also change digits and characters in the Parameter Editor of certain menus.

- **Next** and **Previous** (**Left** and **Right**). These keys are used to set parameters. They are most often used to move along in menu selections to the desired entry.



3 **Lockout Keyswitch**. Sprint iQ is in Run mode when the keyswitch is vertical. Turn the keyswitch counter-clockwise to the horizontal position to enter Program mode. The keyswitch in illustration below is in the vertical position.



4 **USB 2.0 Port**. The port can communicate with USB devices. A memory stick can be inserted and recognized as Drive C:. There is also a similar USB port on the back panel. Only one port may be used at a time.

5 **Start** and **Stop** Switches. The front panel has a *green* **Start** switch and a *red* **Stop** switch. The green switch is used to start the test. The red switch is used to abort a test in progress.

2.2.1 Pass/Fail Lights

The most convenient test result indicators to observe are the pass and fail lights. A green and red light is assigned for each installed channel.

A green pass light signals that the test cycle was completed and all test values were within tolerances stored in the program that ran on that channel.

A red fail light indicates that at least one test parameter went out of tolerance at some time during a test cycle. The fail light turns on if a gross leak occurred, a pressure error value is exceeded, or the product exceeded an established pressure or flow tolerance. Repeated failures can indicate Sprint iQ or external fixtures have set-up problems.

If a fail light turns on during a test, the operator can read the status box on the run display to see why the test was unsuccessful.

2.2.2 Back Panel Components

1 Pressure Regulator 1 (if ordered)

2 Pressure Regulator 2 (if ordered)

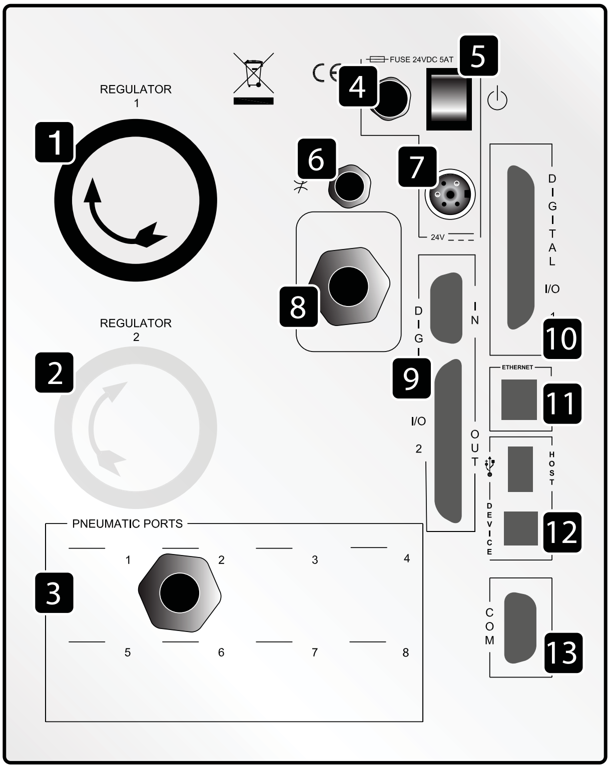
3 Coupling Ports (number varies with tester configuration)

4 Fuse

5 Power Switch

6 Needle Valve (depends on configuration)

7 Power Supply Connector



8 Air Supply Connection

9 Digital I/O #2 (Optional)

10 Digital I/O (Optional)

11 Ethernet Port (Optional)

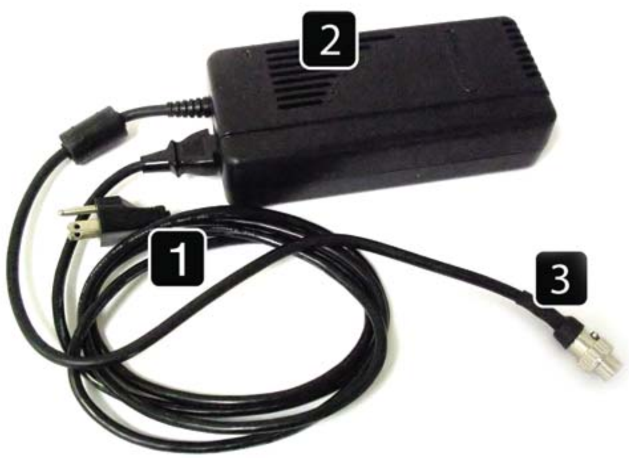
12 USB 2.0 Ports: One Type A and One Type B

13 Serial Com Port

2.2.3 Connecting Power

1. Check that the power switch on the back panel of the tester is OFF.
2. Referring to the figure below, connect the 1 AC power cord to the 2 power supply. (The type of power cord supplied with Sprint iQ will vary, depending on the country.)
3. Attach the 3 DC output power cord to the rear panel of the tester at location shown on page 10 at location 7. Lock it in position by turning the connector collar so that it firmly grips the receptacle.
4. Finally, connect the AC power cord to the facility power receptacle. The green light on the power supply should now be illuminated indicating that the power supply is receiving AC power.

Before switching the tester ON, be sure that the power supply is located in a position where it will be open to air flow and stable.



2.2.4 Switch-On the Tester

Turn the lockout keyswitch to the vertical position.

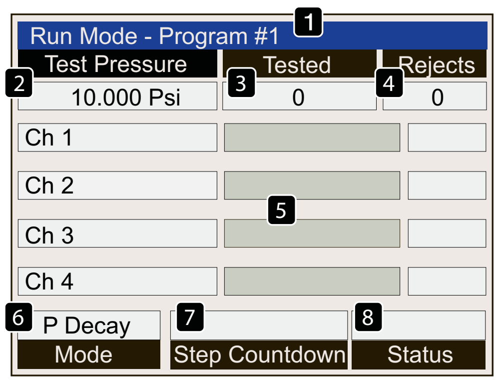
When the power supply is connected correctly as previously explained, press the power switch on the rear panel to turn on the tester.

The tester will begin its initialization process and display a "splash screen" showing the firmware version number.

Initialization will continue as the splash screen remains until the tester finishes and shows the Run Mode display.

2.2.5 Run Mode Display Overview

Sprint iQ shows the Run Mode display during all test cycles in every test mode. If multiple programs are linked, Sprint iQ shows the run display for the program currently running.



1 Program Header. Ninety-nine programs may be stored in Sprint iQ's memory. The header shows the program number that is currently selected for running.

2 Test Pressure Column. This column displays real-time pressure measurements. At the end of a Vent step it shows the pressure that was measured at the beginning of the step. Shows preset pressure before a test is started.

3 Tested Box. Shows number of tests. Counts total times pass and fail lights turn on. Counts up to a maximum of 65,535.

4 Rejects Box. The number of rejected (failed) tests is shown here. This number reflects the number of times the fail light has turned on. The maximum count is 65,535.

5 Channel Number/Bar Graph/ Status readout. The left column shows the Channel Number and pressure at that channel. The middle column displays a color bar graph to help monitor progress on that channel. The bar graph shows an analog trend of what the current test program is measuring. This helps to show whether values are going up or down, and how rapidly values change. The right column shows the pass/fail status information for the last test completed on that channel.

6 Mode Box. The testing mode is shown in this box. Sprint iQ can operate in many modes such as pressure decay (P Decay), flow, burst, etc. This box shows an abbreviated display of what test type Sprint iQ is set to run.

7 Step Countdown Box. The time of each phase counts down during a test. The phases vary depending on the type of test being run.

8 Status Box. Shows what phase a test is in and possible reasons for an unsuccessful test.

2.2.6 Mode Box Messages

Mode Box Display

The test mode is shown in the Mode Box 6. If Sprint is set to run linked tests, the Mode Box shows the first test type in a series. Selected TestMode Box Display

Back P	Back Pressure
Back P Rate	Back Pressure Rate
Crack	Crack
Creep	Creep
Flow	Flow
Flow FF	Flow Fast Flush
Gauge	Gauge
P Burst	Pressure Burst
P Decay	Pressure Decay
P Occ	Pressure Occlusion
P Occ Rate	Pressure Occlusion Rate
P Rise	Pressure Rise
P Rise Rate	Pressure Rise Rate
P SC	Pressure Sealed Component
PD Rate	Pressure Decay Rate
V Burst	Vacuum Burst
V Decay	Vacuum Decay
V Occ	Vacuum Occlusion
V Occ Rate	Vacuum Occlusion Rate
V Rise	Vacuum Rise
V Rise Rate	Vacuum Rise Rate
V SC	Vacuum Sealed Component
VD Rate	Vacuum Decay Rate

2.2.7 Status Box Messages

The status box on Sprint iQ's run display shows information before, during, and after a test. Three kinds of facts are displayed in the status box-test type set to run, test phase, and results of the completed test.

Status Box Messages

These are some of the messages which may display while the Sprint iQ operates.

Couple X	One or more coupling valves have opened, or a test is in a wait period to allow an external fixture to activate.
EOC	End of cycle.
Fill	Product is being filled with air.
Isolate	A test is in isolate stage to ensure a valve is in the correct state before another is activated.
Pre-Fill	Product is being pre-filled with air.
Stabilize	The programmed stabilize time is counting down.
Test	The test phase is in progress.
Uncouple X	One or more coupling valves have opened, or a test is in a wait period to allow an external fixture to activate
Vent	The test part is open to atmospheric pressure.

Channel Pass/Fail Messages

These are some of the messages that may appear in the right column of the channel display.

Gross	Pressure fell below minimum during stabilization phase.
HiBurst	Burst above max setpoint
HiCrack	Crack above max setpoint
LoBurst	Burst below min setpoint
LoCrack	Crack below min setpoint
NoBurst	Burst not detected
NoCrack	Crack not detected
Pass	The last test on this channel passed.
UserAB	Abort: **Stop** switch was pressed.

2.2.8 Test Parameters

Test parameters are setpoints and tolerances that tell Sprint iQ how to conduct a test and decide whether a product is accepted or rejected. Test parameters are set in Sprint iQ's Test Parameters menu.

When Test Parameters are Available

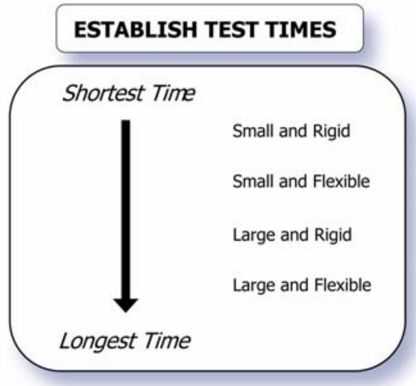
If existing test values are at hand, begin by simply entering those values into the Sprint iQ. Once all values are set correctly, the Sprint iQ is ready for fine tuning.

When Test Parameters are not Available

If there are no established test values, some experimenting is needed to arrive at values for pressures, flow rates, and times best suited to the product. Little effort is required to program Sprint iQ after test parameters are established. Yet, coming up with test values takes consideration when starting from scratch.

Setting Test Time

As test times are developed, keep in mind the size and material of parts to be tested. Parts that are both small and rigid typically require short test times. Parts that are both large and flexible generally require longer test times.



Avoid the Tendency to "Over-Test"

Optimum setup values are typically established after trial and error when working with known good and bad product samples. One point to keep in mind is not to over-test product. Avoid setting leak tolerances too tight with the idea that absolutely no leak is acceptable. Through experimentation you'll probably find that a small pressure drop occurs simply due to how your product behaves during pressurization. Many products create conditions that merely appear to be small leaks when pressurized.

2.2.8.1 Fine Tuning

After you've entered the basic parameters into a program, you're ready to fine-tune your setup. A few tips:

- If not using external fixtures, set coupling time to zero.
- If product blows out of external fixtures, make sure you have a long enough coupling time.
- If you get gross failures when testing a flexible product, try increasing fill time or evacuate (for vacuum tests) time.
- Add fill and stabilize time to slow the decay rate and make it more consistent.
- If your test doesn't need a dump valve to vent product pressure after testing, set the vent parameter to off.
- In a flow test, set test time long enough for the product under test to fill and produce a stable flow rate.
- If repeated parts failures of good parts occur, try widening the pressure error tolerance or adding more fill or evacuate (for vacuum tests) time.

2.2.9 Put Sprint iQ to Work

When everything is programmed and checked out, you're ready to put Sprint iQ to work and start testing products. A few tips:

- Explain controls and run display messages to operators.
- Keep external connections to the product under test as straight, rigid, and direct as possible. Flexible connections can cause inconsistent readings.
- Put Sprint iQ in a place where the pressure regulator and other controls on the back won't get moved around or damaged.

2.2.10 In Case of Trouble

Many difficulties encountered when setting up a new tester are caused by simple things. Address the items in the checklist below to ensure the tester is being operated correctly.

Setup Checklist

- Is the power supply connected to the back panel and is it receiving power (the power supply's green light is lit)?
- Is supply air connected to Sprint iQ?
- Is the supply air clean and dry? Air that contains moisture, oil, or hard particulate ***will*** damage Sprint iQ.
- Is the supply air within the correct pressure range?
- Has the pressure regulator changed from when the test pressure was set? A change will cause pressure errors.
- Has the LOCKOUT keyswitch been set in the appropriate position for the desired task (Run vs. Program mode)?
- Is the product to be tested attached to the test port during all flow tests? Without product, the resulting high flow could damage the flow sensor.
- Has the calibration been changed? Do ***not*** enter calibration mode unless intending to reset calibration data. The necessary standards and instruments to complete the task must be at hand.
- Are engineering units set in the correct units of measure?

If the problem persists, call Uson for help.

Uson's Customer Support Hotline is available at:

+1 281-671-2222

2.2.11 Start Options

The Sprint iQ has options that modify the way it accepts the start input. These options are useful for integrating the Sprint iQ with fixtures that seal on the test part.

Start Options are first categorized as being Local (Front Panel) or Remote (digital inputs on the back panel). This option category is mutually exclusive in that front panel push-buttons are ignored totally when the Remote Option is selected, and vice versa.

2.2.11.1 Local Start Option

The Local Start Option enables the two front panel push-button switch for starting and stopping a test. The green button starts the test. The red button stops or aborts the test.

2.2.11.2 Remote Start Option

The Remote Start Option enables three digital inputs for controlling how the test is started and stopped. The name of the three digital inputs and their description is:

1. Remote Start: a closure that starts the test
2. Remote Start Enable: a closure that indicates a condition that it is safe to start a test (optional dependent on Remote Start Policy)
3. Remote Stop: a closure that aborts the test (optional)

The operations of these three inputs are modified by the Remote Start Policy that has been selected. There are three remote start policies:

1. Fixture Lid Start
2. Interlock Start
3. Anti-Tie-Down Start

Fixture Lid Start

The Remote Start input starts the test cycle. Remote Start must continue to be asserted throughout the test cycle, otherwise, its release aborts the test. Also, Remote Stop can optionally be used to abort the test cycle at any time. The Remote Start Enable input is not used for this start policy and is ignored.

Interlock Start

The Remote Start input starts the test cycle, if Remote Start Enable is already asserted. Typically, Remote Start Enable is connected to a test fixture interlock switch that indicates when it is safe to test. After this condition is attained, some user action is required that asserts the Remote Start input thus starting the test cycle. If Remote Start Enable is released before the test cycle has finished, the test cycle is aborted. Also, Remote Stop can optionally be used to abort the test cycle at any time.

Anti-Tie-Down Start

This start policy requires an external device that implements anti-tie-down operation. The output of this external device is connected to the Remote Start input. The test cycle is started when the anti-tie-down device asserts the Remote Start input for the duration of the coupling time (or times if there are multiple couplings). The intent is to keep the operator's hands safe on the anti-tie-down device and away from pinch points while the fixture is moving to close and seal on the test part. The test cycle is aborted if the anti-tie-down device releases the Remote Start input before the coupling time(s) have completed. Also, Remote Stop can optionally be used to abort the test cycle at any time. The Remote Start Enable input is not used for this start policy and is ignored.

3.0.1 TEST STARTING WHILE IN MENU SYSTEM

While using the menu system, for safety reasons, the **Start** Switch (or the ability to accept a start command) is not always enabled. While navigating in any part of the menu system which has the word “menu” in the title, the tester is prevented from starting a test.

An exception to this rule is allowed while viewing graphs. The tester will accept start commands so that the operator can view the test data on the graphs.

The **Stop** Switch is *always* enabled.

3.0.2 NAVIGATION

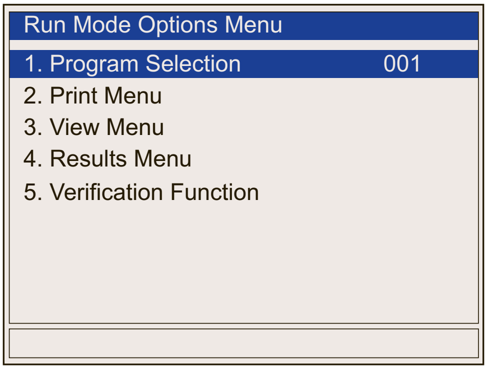
There are two menu systems. One is accessed by pressing Enter at the Run screen to allow easy access to basic features. The other menu system is accessed in Program Mode and allows in-depth changes to system.

This simple menu which is accessed from Run Mode is discussed beginning on the following page.

Remember that Sprint iQ is available in many configurations. Therefore, each tester may not display every menu item shown in the following pages.

3.0.2.1 Run Mode Options Menu

Press the **Enter** button while at the run screen to access the Run Mode Options Menu.



Use the **Up** and **Down** keys to highlight the option name and press **Enter** to select. For example, press **Enter** when Program Selection is highlighted and the “Parameter Editor” will appear (as seen on page 27). The “Parameter Editor” permits easily changing values by using the arrow keys.

Allowable entries in this case are 001 to 100 and are made with the **Left** and **Right** keys. To accept changes, press the **Enter** key. To abort a change without saving press the **Exit** key. Use the exit key after all changes are made to return to the previous menu.

If a selected item is a *menu*, e.g., Print Menu, then pressing **Enter** will open the Print Menu instead of a Parameter Editor. After selections are finished in that menu, exiting will return to the previous menu.

Some parameter entries will be numeric. In such cases it is only necessary to use the **Left** and **Right** keys to position the cursor over the digit to manipulate and then press the Up or Down keys to change it.

The number of digits to enter may vary from what is shown in this manual as it will sometimes depend on the type of units or number formats chosen in setup.

This symbol ⮌ shows entries that cycle repeatedly through the range of values when changing them with the **Left** and **Right** keys.

This symbol ←↑↓→ shows entries that require the **Left**, **Right**, **Up**, and **Down** keys to make entries. This entry method allows precise numbers and text entries to be made.

Press **Exit** from the Run Mode Options Menu main display to return to the Run Mode display.

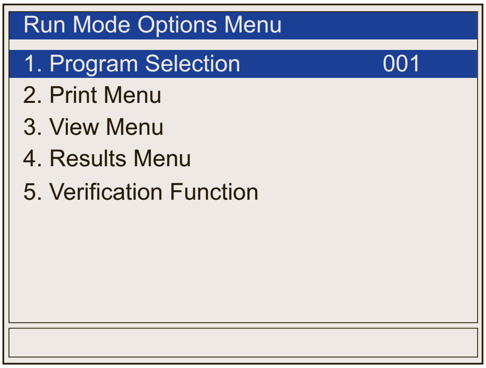
In all cases, if a menu item refers to a feature that is not available, the item will be dimmed and the highlight bar will skip over them.

Run Mode Options Menu

Remember that Sprint iQ is available in many configurations. Therefore, each tester may not display every menu item shown in the following pages.

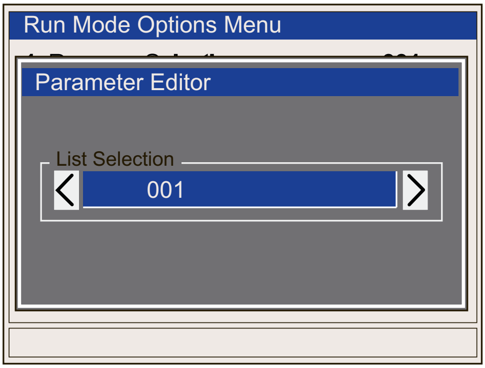
1. Program Selection

This is the top-level menu.



Program Selection........................See page 26
Print Menu..................................See page 27
View Menu...................................See page 28
Results Menu...............................See page 28
Verification Function...................See page 31

Selecting the first option (Program Selection) will open the Parameter Editor for that option.



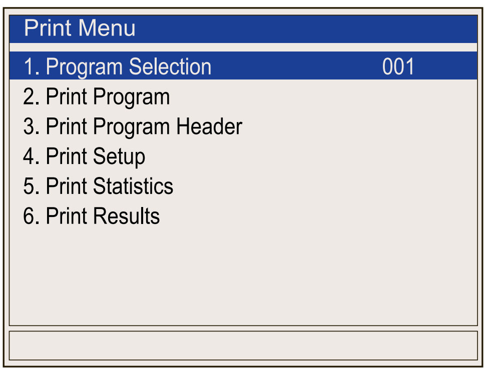
Parameter Editor (001 to 100)

(Use **Left / Right** keys to change selection.)

The remaining items are listed below. To help with staying oriented in the list, the opening menu and any sub-menus are shown.

Always bear in mind that not all functions and items shown here may be available on every Sprint iQ model.

2. Print Menu



1. Program Selection

    ➪ Parameter Editor

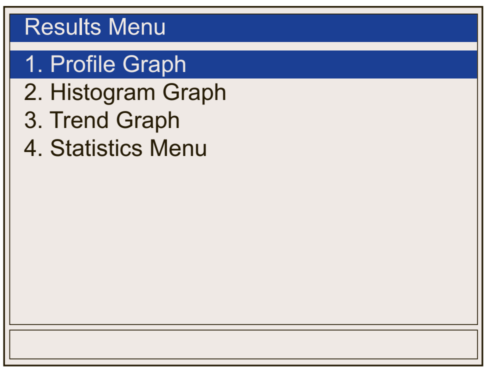
        1 ➜ to 100 ↵ (Program number)

2. Print Program
3. Print Program Header
4. Print Setup
5. Print Statistics
6. Print Results

3. View Menu

    1. Display format
    2. Sensor Type
    3. Channel
    4. Phase

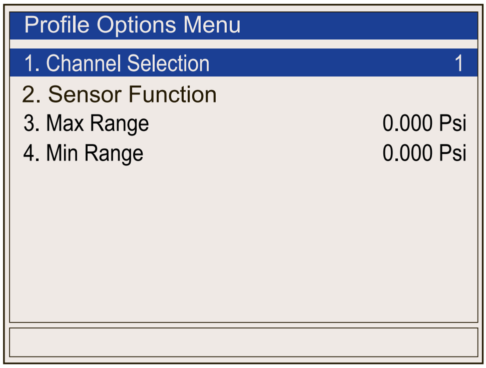
4. Results Menu



1. Profile Graph

Highlight Profile Graph and press **Enter** to see the graph display. Press the **Enter** again at the graph display to go to the Profile Options Menu below.

Profile Options Menu



1. Channel Selection

    ⇨ Parameter Editor

    1 ➜ 2 ➜ 3 ↰

2. Sensor Function

    ⇨ Parameter Editor

    Gauge Pressure ➜ Flow ↰

3. Max Range

    ⇨ Parameter Editor

    +00.000 ➜ to 99.999 ←↑↓→

4. Min Range

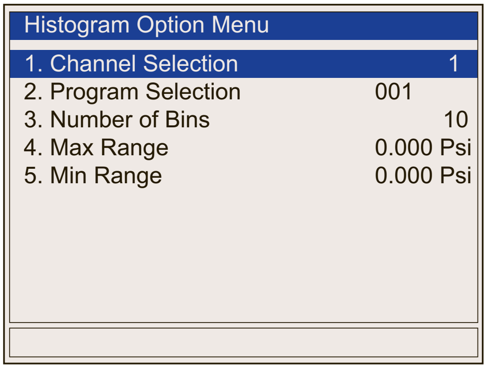
    ⇨ Parameter Editor

    +00.000 ➜ to 99.999 ←↑↓→

2. Histogram Graph

Highlight Histogram Graph and press **Enter** to see the graph display. Press the **Enter** again at the graph display to go to the Histogram Option Menu below.

Histogram Option Menu

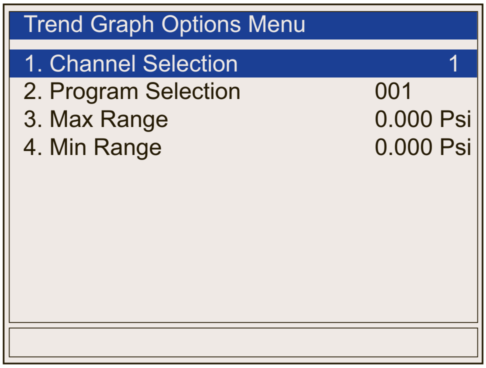


1. Channel Selection
   - ⇨ Parameter Editor
     1 ➜ 2 ➜ 3 ➜ 4 ↵
2. Program Selection
   - ⇨ Parameter Editor
     001 ➜ to 100 ↵
3. Number of Bins
   - ⇨ Parameter Editor
     1 ➜ to 10 ↵
4. Max Range
   - ⇨ Parameter Editor
     00.000 ➜ to ±99.999 ←↑↓→
5. Min Range
   - ⇨ Parameter Editor
     00.000 ➜ to ±99.999 ←↑↓→

3. Trend Graph

Highlight Trend Graph and press **Enter** to see the graph display. Press the **Enter** again at the graph display to go to the Trend Graph Options Menu below.

Trend Graph Options Menu



1. Channel Selection

    ⇨ Parameter Editor

    1 ➜ 2 ➜ 3 ➜ 4 ⮌

2. Program Selection

    ⇨ Parameter Editor

    001 ➜ to 100 ⮌

4. Max Range

    ⇨ Parameter Editor

    00.000 ➜ to ±99.999 ←↑↓→

5. Min Range

    ⇨ Parameter Editor

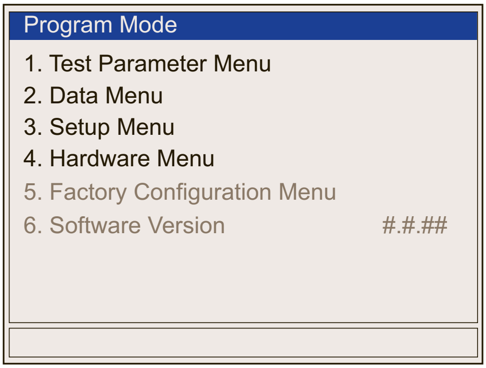
    00.000 ➜ to ±99.999 ←↑↓→

5. Verification Function

When the selections have been set as desired, press the **Exit** button to return to the Run Mode display.

3.0.2.2 Program Mode Menu

Turn the **Lockout Keyswitch** to the horizontal position to go to the Program Mode Menu. The ability to use the menu item will vary depending on the configuration of the particular tester.



Highlight the first item, Test Parameter Menu, and press **Enter**. The Test Parameter Menu will open and the display will appear as shown below. The navigation method is similar in all menus.

Test Parameter Menu ....See page 33

Data Menu ....See page 41

Setup Menu.................................See page 44

Hardware Menu ....See page 46

Factory Configuration Menu ....(Factory use only)

Software Version..........................(Display only)

Test Parameter Menu

Test Parameter Menu	
1. Program Number	001
2. Program Name	001
3. Test Type	Pressure Decay
4. Channel Selection	1
5. Sample Interval	0.1s
6. Sample Channel	1
7. Couple Menu	
8. Fast Fill Menu	
9. Regulator Selection	Test

1. Program Number

   ➪ Parameter Editor

   001 ➜ to 100 ↰

2. Program Name

   This item allows the creation of a customized alpha-numeric name for the program.

   ➪ Parameter Editor (Character Input)

   A ➜ to z, 0 ➜ to 9 ←↑↓→

3. Test Type

   ➪ Parameter Editor

   ➜ Pressure Decay ➜ Pressure Decay Rate ➜ Pressure Occlusion ➜ Pressure Occlusion Rate ➜ Pressure Burst ➜ Crack ➜ Creep ➜ Pressure Rise ➜ Pressure Rise Rate Leak rate ➜ Flow ➜ Back Pressure ➜ Back Pressure ➜ Rate ➜ Sealed Component ➜ Fast Flush Test ➜ Gauge ↰

4. Channel Selection ➜

   ➪ Parameter Editor

   1 ➜ 2 ➜ 3 ➜ 4 ↰

5. Sample Interval

    ⇨ Parameter Editor

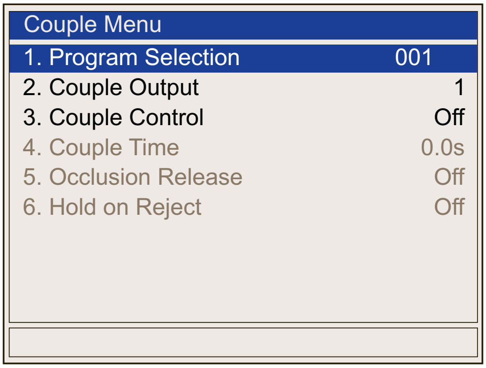
        Off ➜ 0.1sec ➜ to 1.0 sec ↵

6. Sample Channel

    ⇨ Parameter Editor

7. Couple Menu

NOTE: The number of couple outputs varies with tester configuration.



1. Program Selection

    ⇨ Parameter Editor

2. Couple Output

    ⇨ Parameter Editor

        1 ➜ 2 ➜ 3 ➜ 4 ↵

3. Couple Control

    ⇨ Parameter Editor

        On ➜ Off ↵

4. Couple Time

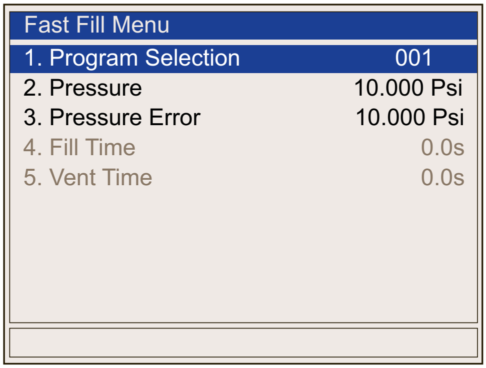
    ⇨ Parameter Editor

        000.0 ➜ to 999.9 ←↑↓→

5. Occlusion Release
   ➪ Parameter Editor
      On ➜ Off ⮌

6. Hold On Reject
   ➪ Parameter Editor
      On ➜ Off ⮌

8. Fast Fill Menu



1. Program Selection
   ➪ Parameter Editor
      1, 2, 3, 4 ⮌

2. Pressure
   ➪ Parameter Editor
      00.000 ➜ to 99.999 ←↑↓→

3. Pressure Error
   ➪ Parameter Editor
      00.000 ➜ to 99.999 ←↑↓→

4. Fill Time
   ➪ Parameter Editor
      00.0 ➜ to 99.9 ←↑↓→

5. Vent Time
    ⇨ Parameter Editor
        00.0 ➜ to 99.9 ←↑↓→

9. Regulator Selection
    ⇨ Parameter Editor
        Test ➜ Vacuum ↰

10. Test Pressure
    ⇨ Parameter Editor
        00.000 ➜ to 99.999 ←↑↓→

11. Pressure Error
    ⇨ Parameter Editor
        00.000 ➜ to 99.999 ←↑↓→

12. Ramp Start

13. Ramp Rate

14. Flow Range

15. Fill Time
    ⇨ Parameter Editor
        00.0 ➜ to 99.9 ←↑↓→

16. Stab Time
    ⇨ Parameter Editor
        00.0 ➜ to 99.9 ←↑↓→

17. Test Time
    ⇨ Parameter Editor
        00.0 ➜ to 99.9 ←↑↓→

18. Vent Time
    ⇨ Parameter Editor
        00.0 ➜ to 99.9 ←↑↓→

19. Leak Calibration Menu

1. Program Selection

NOTE: Must select a Pressure Decay Rate or Vacuum Decay Rate program to enable the menu.

2. Leak Compensation
   ⇨ Parameter Editor
      Enabled ➜ Disabled ↰

3. Perform Leak Compensation Test

4. Leakrate Format
   ⇨ Parameter Editor
      (cycle through decimal formats)

5. Leakrate Units
   ⇨ Parameter Editor
   ml/s ➜ ml/m ➜ ml/hr ➜ cc/s ➜ cc/m ↰

6. Leak Master Value
   ⇨ Parameter Editor
      00.00 ➜ to 99.99 ←↑↓→

NOTE: Decimal places available depend on how Leakrate Format is set.

7. Common Cal Data

8. Channel

9. Perform Comp/Cal Tests

10. Comp. Value
   ⇨ Parameter Editor
      00.000 ➜ to 99.999 ←↑↓→

11. Cal. Value
   ⇨ Parameter Editor
      00.000 ➜ to 99.999 ←↑↓→

12. Pneumatic S/N Ratio
    (Displays as 99999 if Comp Value is set to zero).

13. Verification Control
    ⇨ Parameter Editor
        Enabled ➜ Disabled ↰

14. Verification Tolerance
    ⇨ Parameter Editor
        1% ➜ to 50% ↰

15. Verification Interval
    ⇨ Parameter Editor
        0 hr ➜ to 23 hr ↰

20. Reject Limit Menu

Reject Limit Menu	
1. Program Selection	001
2. Common Limits	Off
3. Channel	1
4. Reject Maximum	0.100 Psi
5. Reject Minimum	0.000 Psi
6. Pass Criteria	In Band
7. Event Limit	0.000 Psi

1. Program Selection

2. Common Limits
    ⇨ Parameter Editor
        On ➜ Off ↰

3. Channel

4. Reject Maximum
    ⇨ Parameter Editor
        +00.000 ➜ to 99.999 ←↑↓→

5. Reject Minimum

⇨ Parameter Editor

+00.000 ➜ to 99.999 ←↑↓→

6. Pass Criteria

⇨ Parameter Editor

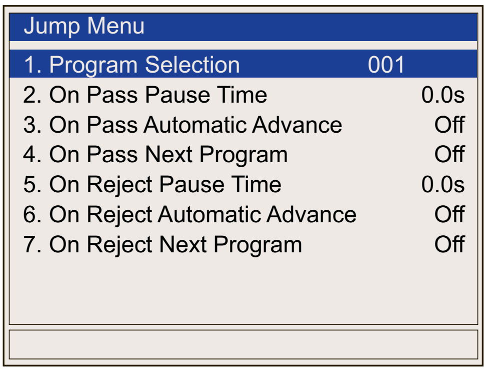
In Band ➜ Above Reject Max ➜ Below Reject Min ↰

7. Event Limit

⇨ Parameter Editor

0.0000 ➜ to 9.9999 ←↑↓→

21. Jump Menu



1. Program Selection

2. On Pass Pause Time

⇨ Parameter Editor

00.0 ➜ to 99.9 ←↑↓→

3. On Pass Automatic Advance

⇨ Parameter Editor

On ➜ Off ↰

4. On Pass Next Program
   ⇨ Parameter Editor
   Off ➜ 001 ➜ to 100 ↵

5. On Reject Pause Time
   ⇨ Parameter Editor
   00.0 ➜ to 99.9 ←↑↓→

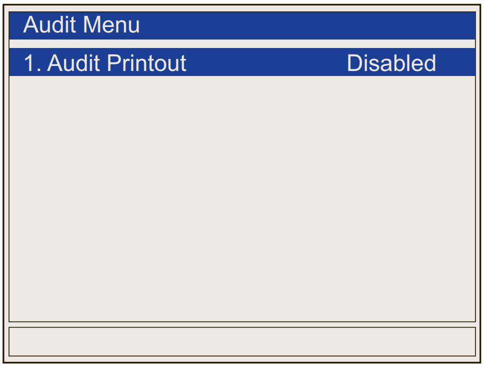
6. On Reject Automatic Advance
   ⇨ Parameter Editor
   On ➜ Off ↵

7. On Reject Next Program
   ⇨ Parameter Editor
   Off, 001 ➜ to 100 ↵

Data Menu

1. Clear All Counters
2. Audit Menu
3. Import Menu
4. Export Menu

Audit Menu



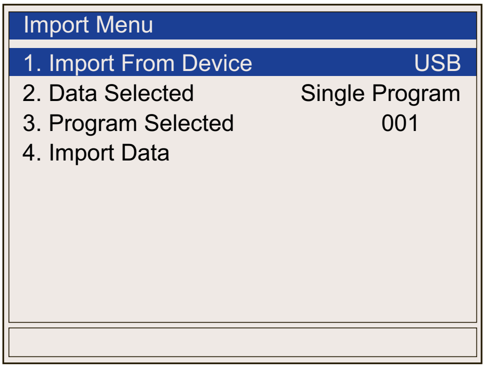
1. Audit Printout

   ⇨ Parameter Editor

   Disabled → Enabled ↵

Statistics Menu

Import Menu



1. Import from device
   ➪ Parameter Editor
   USB

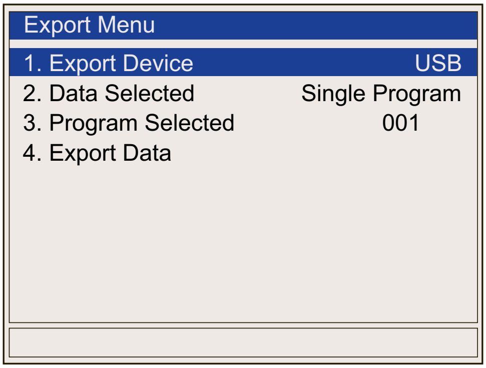
2. Data Selected
   ➪ Parameter Editor
   Single program ➜ Test Channel ➜ Setup ➜ Configuration ➜ All Programs ↵

3. Program Selected

   This selection is not available for modification for all selections made in "Data Selected" above.
   ➪ Parameter Editor
   001 ➜ to 100 ↵

4. Import Data
   ➪ File copy
   Press **Enter** to continue; **Exit** to abort

Export Menu



1. Export to device
   ➪ Parameter Editor
   USB

2. Data Selected
   ➪ Parameter Editor
   Single program ➜ Test channel ➜ Set up ➜ Configuration ➜ All programs ↵

3. Program Selected

This selection is not available for modification for all selections made in “Data Selected” above.

➪ List Selection
001 ➜ to 100 ↵

4. Export Data
   ➪ File Copy
   Press **Enter** to continue; **Exit** to abort

Setup Menu

Setup Menu	
1. Pressure Unit	Psi
2. Flow Unit	smlm
3. Reset Mode	None
4. Remote Start	Off
5. Program Selection	Front Panel
6. Program Input Decode	Undefined
7. Time	09:42:53
8. Date	05/03/2007
9. Language	American

1. Pressure Units

   ⇨ Parameter Editor

   psig ➜ bar ➜ pa ➜ kg/cm2 ➜ cmH2O ➜ inH2O ➜ mmHg ➜ inHg ↰

2. Flow Unit

   ⇨ Parameter Editor

   sccm ➜ scch ➜ slm ➜ smlm ➜ smlhr ↰

3. Reset Mode

   ⇨ Parameter Editor

   None➜Hold on Reject➜ Hold on Pass➜ Infinite Fill ↰

4. Remote Start

This selection is not available unless Remote Start has been enabled in Remote Control, Accessory Menu by Uson.

⇨ Parameter Editor

Off ➜ Conventional ➜ Fixture ➜ Anti Tie Down ➜ Inter Lock ↰

5. Program Selection
   ⇨ Parameter Editor
      Front Panel ➜ Remote Port ➜ Program Mode ↰

6. Program Input Decode
   ⇨ Parameter Editor
      Binary

7. Time
   ⇨ Parameter Editor (Time [hh:mm:ss])
      Hour:Minutes:Seconds ←↑↓→

8. Date
   ⇨ Parameter Editor (Date [mm/dd/yyy])
      Month:Day:Year ←↑↓→

9. Language
   ⇨ Parameter Editor
      American ➜ Chinese ➜ English ➜ French ➜ German ➜ Korean ➜ Portuguese ➜ Spanish ↰

10. Display Contrast
   ⇨ Parameter Editor
      1% ➜ to 100% ↰

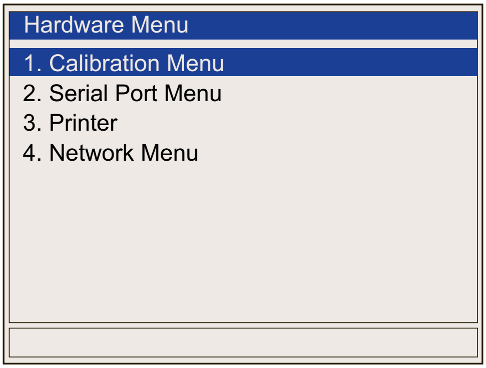
11. Audio Control
   ⇨ Parameter Editor
      Off ➜ Low ➜ Medium ➜ High ↰

12. Audio Timeout
   ⇨ Parameter Editor
      1 second ➜ to 60 seconds ↰

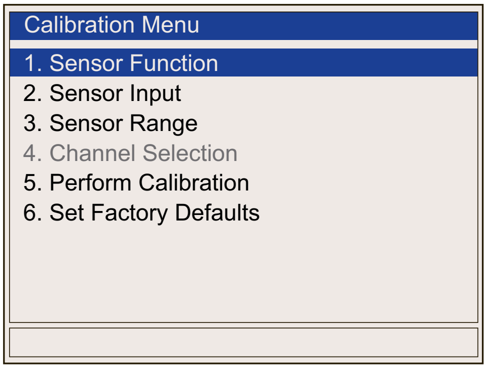
13. Auto Rollover
   ⇨ Parameter Editor
      Disabled ➜ Enabled ↰

14. Reinitialise

Hardware Menu



1. Calibration Menu



1. Sensor Function

   ⇨ Parameter Editor

   Test Pressure ➜ Test Vacuum ➜ Flow ↰

2. Sensor Input

   ⇨ Parameter Editor

   1 ➜ 2 ➜ 3 ➜ 4 ↰

3. Sensor Range

   ⇨ Parameter Editor

4. Channel Selection

5. Perform Calibration

    1. Save

    Greyed out until calibration has been performed.

    2. Target Point

    3. Regulator Setting

    4 Target Point Calibrated

    5. Sensor 1

    6 Sensor 2

    7. Sensor 3

    8. Sensor 4

6. Set Factory Defaults

2. Serial Port Menu

3. Printer

4. Network Menu

4.1 Introduction

Sprint iQ ships with several factory-installed programs with default parameters. These may be kept or changed by the user to suit the actual testing requirements. Please note that not all test types are available in every tester.

You can modify factory-installed programs in any way that is available with the features installed in the tester.

Values stored in factory-installed programs need to be modified to the particular product to be tested. Use the preset values as a starting point in programming.

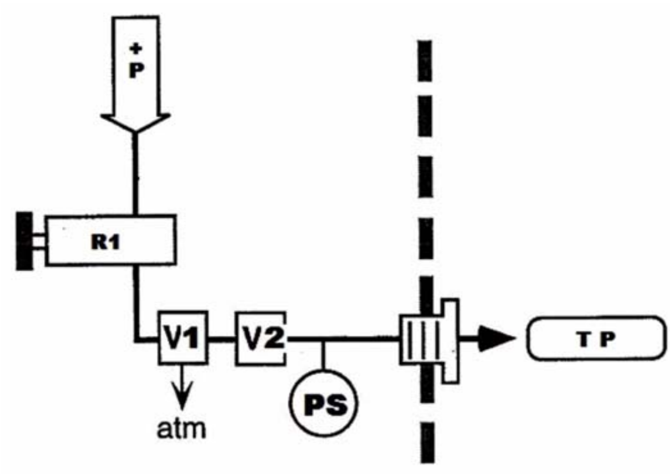
This section explains programming highlights of the following types of tests:

- Decay (Pressure or Vacuum)
- Back-Pressure Flow
- Occlusion
- Flow Measurement
- Leak Check using Flow
- Burst
  - Creep (a subset of burst testing)
- Crack (similar to burst testing, but with two sensors)

4.1.1 Decay Testing

Decay testing applies to testing using either pressure or vacuum. The tester intelligently interprets when pressure or vacuum is used and automatically adjusts readouts and graphs to give the correct presentation.

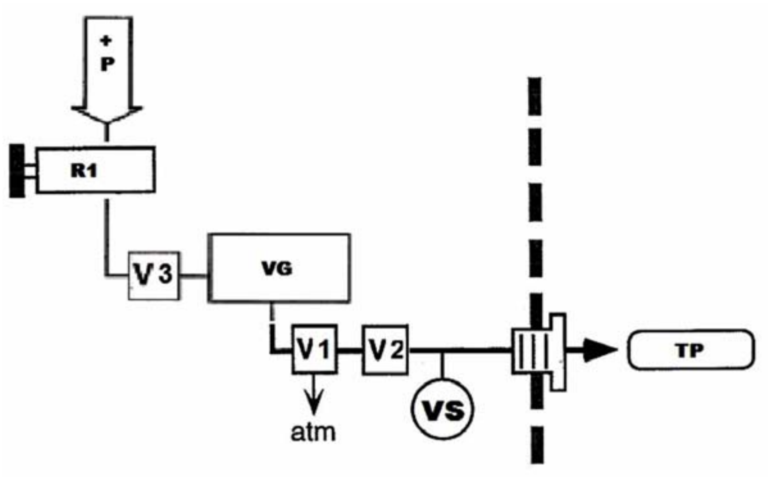
Pressure Decay Testing



1. The part to be tested [TP] is attached to the test port and the test is started.
2. Sprint iQ pressurizes the part with pressure [+P] to the desired test pressure set by the pressure regulator [R1] by opening valves [V1] and [V2] during the Fill step.
3. At the end of the Fill step, pressure is then trapped inside the part as [V2] closes. After a slight delay, [V1] closes allowing the line between [V1] and [V2] to be vented to atmosphere through [V1]. This way, any leakage through [V2] will typically cause the tester to see this leakage and fail all tests. The extra valve allows for a fail-safe configuration.

4. Trapped pressure inside the test circuit is held through the Stabilize step and then measured by Sprint iQ's pressure sensor [PS] during the Test step.
5. If the part exceeds the programmed leak tolerance (pressure drop over time or quantified leak rate), Sprint iQ's display shows why the part failed and displays the pressure loss or leak rate in user defined units of measure.
6. At the end of Test step, pressure trapped in the part is vented to atmosphere through [V1] by opening [V2] during the Vent step, and Sprint iQ is ready to make the next test.

Vacuum Decay Testing



Sprint iQ can be equipped with either:

- a built-in venturi vacuum generator that produces the negative pressure needed to leak test parts of typically small volume (< 1 liter) which must be subjected to vacuum up to 25 inHg/ 12.5 psig.
- an external vacuum pump capable of producing the negative pressure needed to test parts of larger volume (>

1 liter) and/or increased negative pressure (> 25 inHg/ 12.5 psig).

Incorporating a negative pressure sensor, vacuum source (typically), regulator, valves, and logic control, the Sprint iQ handles the task of vacuum testing within a small enclosure.

Most applications can be conducted using Sprint iQ's pneumatically-driven internal venturi vacuum source. The venturi means low noise, no heat, and no maintenance. Also, because the system is so small, it can be placed very close to the test part. With the venturi, no added floor space is required because the vacuum source is right inside Sprint iQ's standard enclosure.

1. The part to be tested [TP] is attached to the test port and the test is started.
2. Positive pressure [+P] is applied to the vacuum generator [VG] through valve [V3]. The vacuum level is set by the pressure regulator [R1].
3. Negative pressure is supplied from [VG] to the test port by opening valves [V1] and [V2] during the Fill step.
4. At the end of the Fill step, negative pressure is then trapped inside the part as [V2] closes. After a slight delay, [V1] and [V3] close allowing the line between [V1] and [V2] to be vented to atmosphere through [V2]. This way, any leakage through [V2] will typically cause the tester to see this leakage and fail all tests.
5. Trapped negative pressure inside the test circuit is held through the Stabilize step and then measured by the tester's vacuum sensor [VS] during the Test step.
6. If part exceeds the programmed leak tolerance (vacuum loss over time or quantified leak rate), the tester's display shows why the part failed and displays the vacuum loss or leak rate in user defined units of measure.

7. At the end of Test step, negative pressure trapped in the part is vented to atmosphere through [V1] by opening [V2] only during the Vent step, and the tester is ready to make the next test.

4.1.1.1 Decay Test Parameters

Parameters which must be set in a decay test:

- Test Pressure
- Pressure Error
- Couple Time
- Fill Time (Evacuate Time)
- Stabilization Time
- Test Time
- Vent (0 or time)
- Reject Maximum (maximum decay)
- Product Volume (optional, to calculate cc/m)
- Next Program

4.1.1.2 Test Pressure

Test pressure is the amount of pressure the product is subjected to during a test. Test pressure is a preset value both stored in the program and set with the pressure regulator. If the regulator is adjusted or inadvertently moved after the target test pressure is set, Sprint iQ stops the test and shows an error in the run display.

The preset test pressure should be very close to the actual pressure from which the product starts to drop. If not, the pressure regulator may have been moved or there is a problem with the supply air to the tester.

When talking about test pressure, we speak about two possible values:

- Preset Test Pressure is the pressure you set using the pressure regulator on Sprint iQ's rear panel. The pressure value is the "ideal" or target test pressure.
- Actual Test Pressure is the pressure the product is subjected to during a test. The actual pressure could be different from the preset test pressure due to variations in product and small changes in the test system. For this reason, you set the pressure error tolerance to allow for a range of acceptable test pressure. The pressure error tolerance is the acceptable difference between the actual test pressure and the target test pressure.

4.1.1.3 Pressure Error

Pressure error is important because:

- it tells Sprint to stop the test if the pressure goes too far above the preset test pressure.
- it tells Sprint to stop the test if the pressure doesn't get close enough to the preset test pressure.

In a pressure decay test, the pressure error is set as an equal plus and minus tolerance around a nominal test pressure value. Enter the number in pressure units and Sprint iQ sets both the high and low pressure error values. Sprint iQ monitors pressure error during the fill and stabilization phases of a pressure decay leak test.

In a flow test, pressure error is checked at the end of test time to allow for the necessary pressure drop caused by the flow.

4.1.1.4 Timers in Decay Tests

Couple Time

Couple time is used as a delay causing Sprint iQ to wait for a preset period after start is activated and before Sprint iQ supplies air to the part to be tested. Couple time can be used in either a manual or automated operation.

If coupling valves are used, the valves turn on at the start of the test and turn off when the test is finished.

Couple time is generally the period in which the pneumatic or mechanical fixtures are applied to seal the product from atmosphere. Often used in open-ended products such as tubing, catheters, and containers.

If external fixtures are not used, set the couple time to zero time (off).

Fill Time

At the start of fill time, a valve opens to pressurize the product. Fill duration depends on the size and construction of the part to be tested. Optimum fill time pressurizes the part fast enough for a good throughput, yet not so fast that the product is still expanding during test phase. Large products require a longer fill time than smaller products. At the end of fill time, Sprint iQ closes the supply air valve and pressure is trapped inside both the part and Sprint iQ's test circuit.

In a test using vacuum, fill time is actually evacuation (evac) time.

Stab Time

This time is provided to let pressure settle before going into the test phase. Best established through trial and error, stabilization time varies depending on product characteristics. Start with stabilize and test times that are equal to each other. The Stabilize time is used to get the maximum separation and repeatability in test results between a known good part and a borderline failure. If the same part is tested repeatedly and the leak result is inconsistent, you probably need to increase the stabilization time. The smaller the leak, the longer the time.

Test Time

In a pressure decay test, test time is the period when Sprint iQ takes measurements to determine the amount of pressure drop from a stabilized pressure. The instant the test enters test phase, Sprint iQ takes the first pressure reading and stores this value **P1**. At the end of test phase, Sprint iQ takes a final reading and holds this value as **P2**. The difference between **P1** and **P2** is the total test pressure loss over the test time. Test time must be long enough to distinguish between good and bad parts. The smaller the leak the longer the time.

Vent Time

Set vent to specific time or 0 for off. When active, vent opens a valve at the end of test time to vent the product and Sprint iQ’s test circuit. If the operator or automated equipment removes the products and vents the pressure, then vent is generally unnecessary (unless test pressures are more than 50 psig) and this parameter should be set to off. Vent is valuable when multiple tests are linked and you need to vent pressure before starting the next step in the series. When set to auto Sprint iQ activates the dump valve and monitors the pressure until the pressure drops below 0.5 psig, then closes the valve to be ready for the next test.

4.1.1.5 Delta Pressure

The Delta Pressure is the amount of pressure change from the first pressure measurement in test phase (**P1**) to the last pressure measurement in test phase (**P2**). Decay rate is the pressure drop divided by time.

$$\frac{P1 - P2}{\textbf{Test Time}} = \textbf{Decay Rate}$$

Although Sprint iQ takes continuous pressure measurements from the start of fill time, only two readings are used to calculate the pressure drop-the first reading at the start of test phase and the last reading at the end of test phase. Sprint iQ uses the pressure drop to compare to the maximum allowable loss (known as the reject maximum) to decide whether a product is accepted as good or rejected as bad. The reject limit you enter into the parameters menu is generally a low pressure value, such as 0.050 psig, because the reject pressure is the drop from the first pressure reading, not the full pressure on the scale.

Reject Maximum, Reject Minimum (Reject Limits)

This the setting for the pressure limits allowed in a product during the test phase before a reject is triggered. These settings are made in the **Reject Limit Menu** under the **Test Parameters Menu** (see page 38). The level is the difference between the actual test pressure (**P1**) and the test pressure unit values you enter. The menu allows easily selecting how the limits will be used as **Pass Criteria** to decide the outcome of the test. For example, if the “In Band” Pass Criteria is chosen, if the pressure is equal to or within the max and min setting at the end of test phase, the product passes. The instant the pressure change exceeds a limit in test phase, the test ends and the reject light turns on. If vent is set on, the dump valve opens and vents the pressure to atmosphere without waiting for the test phase to finish.

Gross Leak

A gross leak is detected when pressure drops below the negative pressure error during stabilization time. When a gross leak is detected, Sprint iQ stops the test and shows Gross in the status box on the run display.

A gross leak is generally caused by a product having a severe defect or because external fixtures are not sealing the product. If you repeatedly get gross error messages and neither the product or the fixture seals appear to be the problem; consider increasing the fill time, the pressure error tolerance, or both. Also at fault could be the test pressure setting. Make sure the pressure regulator has not been moved and the actual applied pressure closely matches the preset test pressure.

4.1.1.6 Pressure Change Calc. (Leak Rate)

In tests such as Pressure Decay Rate, Sprint iQ calculates the leak rate from the pressure change over time using values derived from the following formulae.

Variable Definitions for the Calculations:

CalRate = Leak Master Leak Value (user-entered value)
Tare = Measure at the Start of a Step
EndMeasure = Measure at the End of a Step

Compensation:

$$\textbf{Comp Value} = \textbf{EndMeasure}_{\textbf{comp}} - \textbf{Tare}_{\textbf{comp}} \text{ (using non-leaking master part)}$$

Calibration:

$$\textbf{Cal Value} = \boldsymbol{EndMeasure}_{\textbf{cal}} - \textbf{Tare}_{\boldsymbol{cal}} - \textbf{Comp} \text{ (using Leak Master)}$$

Test:

$$\textbf{Leak} = \frac{(\boldsymbol{EndMeasure}_{\boldsymbol{test}} - \textbf{Tare}_{\boldsymbol{test}} - \textbf{Comp})}{\textbf{Cal}} \times \textbf{CalRate}$$

The **Comp Value** and **Cal Value** can be seen (and edited) on the Leak Calibration Menu.

The concept previously known to many as the “comp/cal ratio” is employed in the Sprint iQ as the **Pneumatic Signal/Noise Ratio** (PSN ratio) and is discussed page 60. Like the Comp Value and Cal Value, the PSN ratio appears on the Leak Calibration Menu.

4.1.1.7 Pneumatic Signal/Noise Ratio

The larger the PSN Ratio, which is the Cal Value divided by the Comp Value, the more repeatable the test will be. The PSN Ratio can be in the range of 0.2 to 0.25 if +/- 10% test repeatability is sufficient.

So for pressure decay tests, the following rules are strongly recommended:

Comp Value ≥ 0
PSN Ratio (Cal / Comp) ≥ 0.2

Cal Value ≥ 0.05% of full scale of the sensor

For PSN Ratio, the larger the better. Longer test times typically yield a larger PSN Ratio.

If the Comp Value is set to zero, the PSN Ratio will display as 99999.

4.1.2 Back-Pressure Flow Test

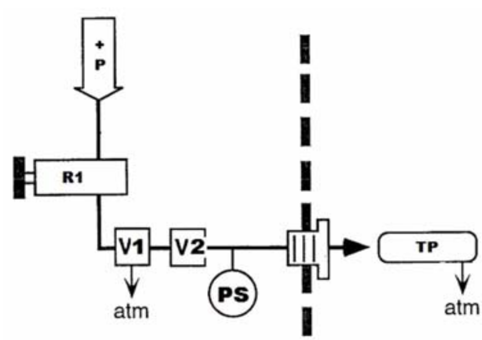
Many devices are constructed with large passages that not only must remain open but also be open a minimum amount to function normally when in use. In some cases, the part's passages have a sufficient tolerance that more precise testing such as mass flow is not necessary or within the project's budget.

A back-pressure test is typically suitable for parts with large passages and therefore high flow rates. An occlusion test, discussed on page 64, is typically used on smaller parts

Sprint iQ testers can conduct back-pressure flow testing by using the same basic pneumatic circuit employed in pressure decay. The programming is the only difference since the part is not expected to maintain pressure. The part is continuously pressurized while air is escaping to atmosphere through the passages being checked. The residual pressure (back-pressure) seen at the parts inlet is measured and must remain within a specific range of pressure defined by reject maximum and reject minimum to pass the test. Thanks to the commonality of test circuits, it is possible (and quite common) to conduct pressure decay tests followed by back-pressure flow tests.

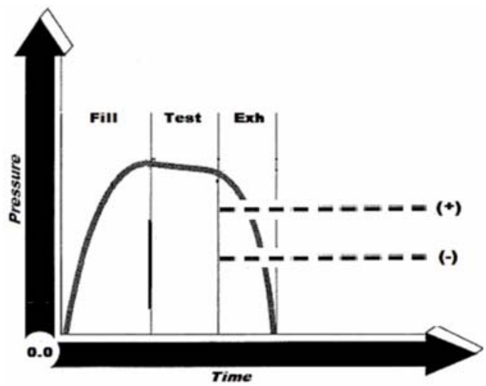
How Back-Pressure Flow Testing Works

1. The upstream end of the part to be tested [TP] is attached to the test port and the downstream end of the part is left unsealed and open to atmosphere.



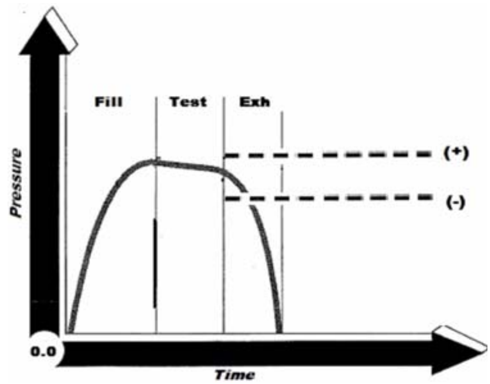
2. Part is pressurized with positive pressure [+P] to the desired test pressure set by the pressure regulator [R1] by opening valves [V1] and [V2] throughout the test.
3. At the end of Test step, Sprint iQ looks for a specific back-pressure using its pressure sensor [PS].
4. If the measured back-pressure during the Test step is outside accept/reject setpoints entered into the test program, the Sprint iQ's display shows why the part failed.
5. At the end of the test, any remaining pressure trapped in the part is vented to atmosphere through [V1] by opening [V2] only, and Sprint iQ is ready to make the next test.

Rejected Vs. Accepted Tests



The figure illustrates a typical back-pressure flow test sequence in which the part under test fails the evaluation. The part in this example fails because the residual back-pressure seen at the inlet of the part (while the outlet is vented to atmosphere) was not within the established limits (reject minimum and maximum), indicating that the passage was the wrong size.

The figure to the right shows a typical back-pressure flow test in which the part passes the evaluation. In this example, the residual back-pressure seen at the part's inlet (while the outlet is vented to atmosphere) was within the established reject minimum and reject maximum limits, indicating that the passage was the correct size.



4.1.3 Occlusion (Blockage) Test

An occlusion test (also called a blockage test or a gross pressure loss test) is a method of testing in which pressure in an open product must drop below a set level for a pass condition. Occlusion tests are generally used to evaluate products that have openings to check for potential blockages or obstructions of the flow path. Generally, occlusion tests are used on parts which are not large enough to work well with a back-pressure test.

All occlusion test parameters are the same as in a pressure decay test. The reject maximum and reject minimum is the reverse of a pressure decay leak test. Rather than expecting the part to hold pressure we now expect the pressure to flow to atmosphere. In an occlusion test, a good part is expected to leak (or flow) so the reject value must be greater than a given value.

For simplicity, the definitions of all the parameters or how to program will not be explained here. For more information see the explanation of a pressure decay test.

Results in Pressure Decay or Flow Rate (Volume/time)

The results of an occlusion test are usually displayed in pressure drop. The tester can also display the result in units of cubic centimeters per minute (ccm). Simply enter the volume of the part under test to activate the conversion to ccm flow rate. When zero is entered as the product volume, the calculation to ccm is disabled and the results are displayed as pressure loss in units of psig.

Occlusion Test Examples

The same pneumatic circuit employed in pressure decay testing is used in occlusion testing; only the programming is different.

Thanks to the commonality of test circuits, it is possible to conduct pressure decay tests followed by occlusion tests. This is easy to accomplish with Sprint iQ's program linking ability.

Typically, a pressure decay test is conducted first, then the product is opened to atmosphere and an occlusion test is made.

Sealing the Product

Occlusion tests can be conducted by using a clamping device to seal the product during the fill time and releasing the seal to allow the product to flow to atmosphere. Alternatively, the product can be opened to the atmosphere throughout the entire test.

An occlusion test can be run with or without a clamping device to seal off the product. Examples of both are given below.

Occlusion Test with External Seal

The occlusion test can be set up to work like this:

1. The operator connects a product to the test port and the open end of the product is placed in the sealing (clamping) fixture. The operator then pushes the START switch. Or the start could be activated by automated equipment.
2. The couple timer provides delay time needed to activate the fixture before starting the test. A coupling valve can be used to supply air to the fixture and hold the seal until the test ends.
3. At the end of couple time, the pressure decay valve opens and fills the product with air. Sprint goes into the stabilize phase only if test pressure is within the pressure error tolerance at the end of the fill phase.
4. At the end of fill time, valves close trapping air inside the product including the Sprint iQ's internal test circuit. Stabilization time lets the pressurized product settle before Sprint iQ starts taking pressure drop readings. For large flow rates stabilization time is not needed and can be set to zero.
5. At the end of stabilization time, Sprint iQ starts looking for a drop in pressure from the stabilized pressure.

Sprint iQ goes into test phase only if test pressure is within the pressure error tolerance.

6. During test time, the coupling is released and the test part is opened to atmosphere. Sprint iQ compares the pressure drop to the set limits. IF the pressure decay (or pressure loss) is greater than the reject minimum at the end of test time, the pass indicator lights up. The fail light turns on if the pressure is less than or equal to the reject minimum. Messages in the status box stay on until the next test.
7. If the vent parameter is set a time other than zero, the vent valve vents the product to atmosphere. If another test is linked to the occlusion test, Sprint iQ goes to the next linked test in the series as long as the product passed all tests.
8. At the end of all linked tests, the operator (or automated machinery) removes the product and Sprint iQ is ready to begin the next test.

Test Time Occlusion Test Pass

The product is pressurized while the clamping fixture seals the open end of the product. The pressure drops below the reject limit within the established test time after the sealing device opens and allows the product to flow to atmosphere.

The significant pressure drop in the product indicates that the product under test flows freely to atmosphere and thus is not blocked.

Test Time Occlusion Test Fail

If the flow path were to be blocked, the product would fail because the air loss from the product would not be enough for pressure to drop more than the reject minimum in the test time.

Occlusion Test without Seal

The occlusion test can also be set up to work like this:

1. The operator connects a product to the test port and the open end of the product is allowed to flow to atmosphere. The operator then pushes the START switch. Or the start could be activated by automated equipment.
2. The couple timer will not be used for this test. (The couple timer provides delay time needed to activate the fixture before starting the test.)
3. At the start of fill time, the pressure decay valve opens and fills the product with air.
4. IF the part is blocked the test pressure will rise too high during the fill time, above the pressure error limit, and the test will fail. This is a fast test for a relatively large change in the flow rate. At the end of fill time, valves close stopping the flow of air to the product.
5. Stabilization time will not be used in this test. (For large flow rates stabilization time would allow the pressure to flow out before pressure drop readings can be taken in the test time.) Sprint iQ goes into test phase only if test pressure is within the pressure error tolerance by the end of the fill phase. (Again, no stabilize time is needed for large flow rates.)
6. During test time, Sprint iQ compares the pressure drop to the reject minimum. IF the pressure decay (or pressure loss) is greater than the reject minimum at the end of test time, the pass indicator lights up. The fail light turns on if the pressure is less than or equal to the reject minimum. Messages in the status box stay on until the next test. Note: If the fill time check is sufficient for your needs, the test time may be set to 0.1 second and a small decay value entered to allow this portion of the test to always pass.
7. If the vent parameter is set to Auto, or a time. The vent valve vents the product to atmosphere. If another test is linked to the occlusion test, Sprint iQ goes to the next

linked test in the series as long as the product passed all tests.

8. At the end of all linked tests, the operator (or automated machinery) removes the product and Sprint iQ is ready to begin the next test.

The product is pressurized during fill time, and the pressure is not able to rise above the pressure error limit. The test part's flow path is open to atmosphere throughout the test.

Test pressure is set while flowing

When setting the test pressure a known good part is used rather than simply blocking the test port. By flowing through a part the pressure can be set at the level expected when the flow path is open.

Fill Time Occlusion Test Pass

The significant flow through product keeps the test pressure from rising and thus is not blocked.

Fill Time Occlusion Test Fail

If the flow path were to be blocked, the test pressure will rise indicating that the flow path is blocked. The test will fail in the fill time because the pressure is above the pressure error limit.

4.1.4 Flow Test

Introduction

A flow test continuously supplies air to a product under test and measures the amount of air flowing through the product and going to atmosphere. In a flow test, Sprint iQ uses at least one mass flow sensor to measure the air flow, and a pressure transducer to monitor the air pressure.

The flow test can be configured to measure air flow through a product and to pass that product if air flow is between the minimum and maximum limits set in the program. Flow tests are often used to check for blocked passages in small tubing and other low-flow devices.

Most parameters in a flow test are the same as a pressure decay test with three exceptions. (1) A flow test has no stabilization phase. (2) Instead of one reject setpoint, a flow test has both reject minimum and reject maximum flow setpoints. (3) Pressure error is checked only at the end of test time.

4.1.4.1 Flow Test Parameters

Parameters in a flow test-

- Test Pressure
- Pressure Error
- Couple Time (if external fixtures are used)
- Fill Time (only required on large products)
- Test Time
- Vent (0 or time)
- Max Flow (maximum flow)
- Min. Flow (minimum flow)

- Next Program

Protect the Flow Sensor
Do NOT run a flow test unless product is attached to Sprint iQ's test port. Without this restriction, the high flow rate could damage the flow sensor.

Pressure Error in a Flow Test

Pressure error is used to make sure pressure is at the target level to perform a flow test. This is necessary because flow rate changes as pressure changes. Pressure error in a flow test functions much like pressure error in a pressure decay test except pressure error is checked at the end of the test phase. Figure 53.

Pressure error is set by entering one pressure number. Sprint iQ sets the positive and negative pressure error around the nominal test pressure.

If air pressure at the end of test time is below the minimum pressure error value, Sprint iQ stops the test. If vent is active, Sprint iQ vents the air to atmosphere. In this case, Sprint iQ displays an error message in the status box on the run display.

Flow Test Stabilization

Stabilize phase is not available in a flow test, so when setting up a flow test, make sure the test time is long enough for the product to reach a steady flow rate.

If the air pressure at the end of test time is above the maximum pressure error value, Sprint iQ stops the test and if vent is active, vents the air to atmosphere.

Flow Setpoints

Besides pressure error tolerance, flow testing requires two independent setpoints for flow rates- minimum and maximum flow. To pass a flow test, the product must be within the pressure tolerance and also within both flow setpoints at the end of test time.

If both the pressure error and flow tolerance are exceeded during a test, the pressure error will be displayed because pressure error has priority over flow tolerance.

If the air flow measured by Sprint iQ's mass flow sensor is below the minimum setpoint at the end of test phase, Sprint iQ turns on the reject light and shows LOW in the status box on the run display.

If vent is active, the dump valve opens and pressure is vented to atmosphere.

Fill time in a Flow Test

Use the fill time in a flow test to get the product pressurized and flowing properly before taking flow readings. This protects the flow sensor from overpressure and provides more consistent flow readings.

If vent is active, the vent valve opens and pressure is vented to atmosphere.

4.1.4.2 Leak Test Using Flow

You can use Sprint iQ to check for leaks using flow. When setting up this kind of test, you set the minimum flow rate to zero. The maximum flow setting is then set to the maximum flow rate you wish to accept. The exact flow rate depends on your product characteristics and specifications.

When to use a flow leak test

A leak test using flow is often an excellent option when certain conditions apply. If your product is small and the acceptable leak rate is relatively high, a leak test using flow can be much faster than a pressure decay test. This is because a flow test conducted on a small product requires no fill or stabilization time. Typical leak tolerances used in flow leak testing are roughly 1.0 sccm for small rigid products, and 5.0 sccm or greater for larger and more flexible products.

If the acceptable leak rate is relatively small (less than the rates discussed above) a pressure decay test is probably your best choice for leak testing. Call Uson to discuss your special testing needs. We specialize in helping test engineers come up with the very best tests for a wide range of products.

When setting the maximum flow setpoint, you'll need to experiment to find the best setting. The maximum flow setting is typically quite high above zero to allow for high speed testing-the reason to use a flow leak test in the first place. If the maximum flow setting is set too close to zero and the time is kept short, a high number of rejects could occur simply due to inconsistencies among the products tested. Atmospheric and room pressure changes could also cause errors if the maximum setpoint is set too close to zero.

Protect the Flow Sensor

Do NOT run a flow test unless product is attached to Sprint iQ's test port. Without this restriction, the high flow rate could damage the flow sensor.

In a leak test using flow, you have the option of using fill time or going straight to test phase. Fill time is usually needed for large parts that need to fill with air before they start flowing. Small parts can often do without fill time because they fill up and start flowing immediately. The flow rate is displayed for both during the fill and test phases.

4.1.4.3 Flow Sensor Over Pressure Limits

The flow sensor in the Sprint iQ can be damaged by too much pressure. The Sprint iQ automatically monitors the pressure and will stop a flow test if the pressure is too high. The below table shows the maximum pressure associated with each flow range.

Flow Range	Over Pressure Limit
10 sccm	15 psig Max
50 sccm	15 psig Max
200 sccm	15 psig Max
1,000 sccm	15 psig Max
5,000 sccm	60 psig Max
20,000 sccm	60 psig Max

4.1.5 Burst Test

In burst testing, Sprint iQ looks for devices to open at some point during pressurization and rapidly drop toward zero pressure. Achieving the burst is the desired outcome of the test. When the burst occurs in the correct pressure range and time period, Sprint iQ gives a pass indication. Test engineers often use a burst test to check pressure relief mechanisms designed to open within a preset pressure range. Burst tests are also used to check the friction relief-point of hydraulic and pneumatic devices.

Flow Control

Use Sprint iQ’s built-in flow control on the back of the tester to set the pressure increase, also called ramp rate. Trial and error is used to adjust the flow control to get the best rate of pressure increase.

A burst test is built around two test conditions:

1. Peak Pressure (P)

Peak Pressure is a constantly updated value before the burst. Sprint iQ uses the peak pressure reading as the starting point to measure the event value. After the event the final peak value is compared to the minimum and maximum burst setpoints to decide whether the product is accepted or rejected.

2. Event (E)

Event is the amount of pressure drop from the peak pressure. When a burst occurs product opens to atmosphere and the pressure begins to rapidly drop to zero pressure.

Event Value (End of Test Trigger)

Event value is a setpoint entered in the parameters menu. Event value is the peak pressure minus the event pressure. In other words, how much the pressure drop is needed from a peak pressure to be considered a real burst. For example, an event value setting of 0.2 psig means the product must drop at least 0.2 psig below the peak pressure to trigger an end of test and a pass/fail decision.

Parameters in a Burst Test

Burst testing uses some of the same parameters used in pressure decay and flow testing, with three major differences:

1. A burst test has only couple and test timers.
2. Pressure error is not used in a burst test.
3. A burst test uses a trigger or threshold setting called an event value, which is a drop in pressure from a peak pressure reading immediately before the product opens to atmosphere.

Parameters to be set in a burst test:

- Test Pressure
- Couple Time
- Test Time
- Vent (0 or time)
- Max Burst (maximum burst level)
- Min Burst (minimum burst level)
- Burst Event (amount of pressure drop to be detected)
- Next Program

Minimum and Maximum for Burst

Minimum and maximum setpoints establish a window in which a burst event must take place to be a pass. If the burst occurs below the minimum setpoint, the test is stopped and LoBurst appears in the status box on the run display. The fail light turns on.

If pressure goes above the maximum setpoint without the product bursting, Sprint iQ stops the test and shows HiBurst in the status box on the run display. The fail light turns on.

If product fails to reach a peak pressure above the maximum burst setpoints before the end of the test phase, Sprint iQ stops the test and shows NoBurst in the status box on the run display.

4.1.6 Creep Test

A subset of burst testing is creep testing. Use Sprint iQ's burst parameters menu (test type Burst) to setup a creep test. A creep test is often used to test products such as blister packages that need to hold a certain amount of air pressure without failing, although the package may increase in size or creep up during the test. A creep test is programmed by using a burst program, so there is no creep parameters menu.

The only difference between a standard burst test and a creep test is that in a creep test the minimum and maximum setpoints are set to the same value.

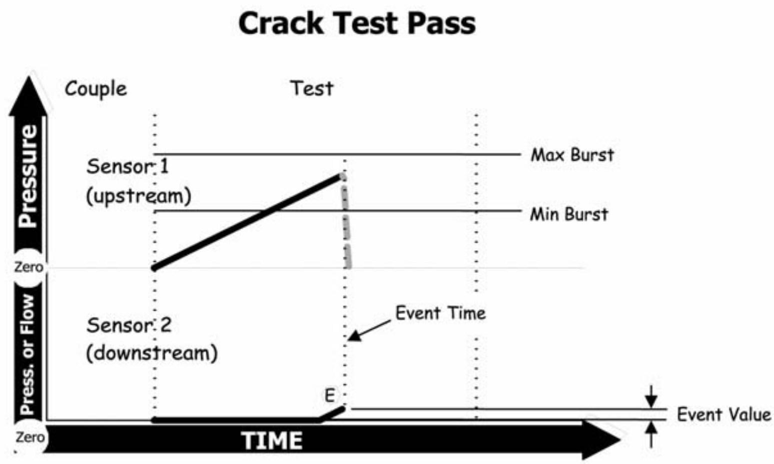
Setting the minimum and maximum setpoints to the same pressure causes Sprint iQ to pass product reaching the min/max pressure setting. Products not reaching the min/max setpoint in the allowed test time are rejected. Products opening to atmosphere (bursting) before reaching the min/max setpoint are also rejected.

Use the same procedure for programming a Burst Test to enter values for a creep test. Everything is set the same way as a burst test except that the min and max setpoints are set to the same pressure value.

4.1.7 Crack Test

Crack testing is a test in which the Sprint iQ is used to detect a slight opening or change in pressure. Crack testing is used in devices such as valves intended to open a certain pressure range. Because a crack is desired, a pass indication is given if the crack happens within established tolerances.

Crack testing is related to burst testing. A burst test is used with products that open quickly to atmosphere and create a dip in pressure called an event. In some products the event is too small or the pressure does not drop at all. A crack test uses a second sensor downstream from the part to catch a pressure rise or flow coming out of the part.



Downstream Sensing

In some test parts, the crack (pressure change) is so gradual or low in magnitude that the sensor can't detect the pressure change. This isn't a fault of the sensor, rather the placement of the sensor in the test circuit becomes an issue. Being upstream from the product, the normal sensor is subjected to constant makeup air.

To test products that open slowly or merely "weep," Uson can provide a separate sensor used downstream from the cracking device to detect very slight pressure or flow changes. In this arrangement, the downstream sensor measures the small pressure or flow variations caused by changes in the product being tested. This arrangement works if downstream air can be routed back to Sprint iQ.

The Crack Event

For a crack test, Sprint iQ is equipped with two sensors. The standard transducer measures the pressure rise being feed to the test part, on the upstream side. The second sensor is the downstream sensor. The crack event is a change in pressure or flow on the downstream side of the test part. This downstream sensor can be either a pressure or flow sensor.

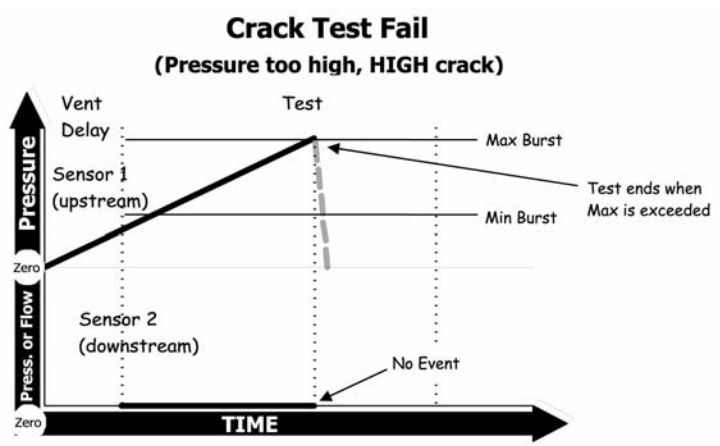
Two measured values are associated with an event value:

- The peak pressure attained. (Upstream side)
- The amount of pressure or flow rise. (Downstream side)

Both sensors are monitored at the same time. To register as a pass, the upstream peak pressure must be within the min and max crack window AND the downstream pressure or flow must exceed the event setting. For example, if the event is set at 0.05 psig, the down stream pressure is monitored till it increases more than 0.05 psig. At that time: the peak upstream pressure must fall within the minimum and maximum crack settings for the test to pass.

Programming a Crack Test

The parameters of a crack test are set in the same manner as a burst test.



4.1.8 Pass/Reject Jumps

The Sprint iQ tester has additional control to link the test programs together based on either a pass or reject condition. This feature also adds the ability to pause the test sequence between linked test programs.

Jump Menu	
1. Program Selection	001
2. On Pass Pause Time	0.0s
3. On Pass Automatic Advance	Off
4. On Pass Next Program	Off
5. On Reject Pause Time	0.0s
6. On Reject Automatic Advance	Off
7. On Reject Next Program	Off

On Pass vs. On Reject

The settings are separated into two groups On Pass and On Reject. The lines associated with On Pass control actions that are only executed if the part passes and the test is accepted. The lines associated with On Reject control actions that are only executed if the part fails and the test is rejected.

4.1.9 Timers

Timers are set in tenths of seconds, and each timer can be set to a maximum of 99.9 seconds. Timers are adjustable for pressure decay, flow, and burst testing. Timers for each test type have identical functions for each test mode, yet the number of possible timers may vary with each test type as seen in this listing:

Timers Used in Decay & Occlusion Testing

- Couple Time
- Fill Time
- Stab Time
- Test Time
- Vent Time

Timers Used in Flow Testing

- Couple Time
- Fill Time
- Test Time
- Vent Time

Timers Used in Burst Testing

- Couple Time
- Test Time (will stop sooner when event in sensed)
- Vent Time

In Run Mode, the display shows the time in the box labeled Step Countdown. All timers count down from the preset value to zero. The Status box shows what phase the test is in during timer countdown.

5.0.1 General Specifications

Display: 5.7” Diagonal 320 x 240 Color Graphic Backlit LCD

Languages:
English (UK and US), Spanish, German
(user selectable). Custom languages also available

Program/Setup Storage: 100
(99 alpha-numeric namable & 1 diagnostic)

Test Channels Available:
1, 2, 3 or 4 (sequential or concurrent)

Pressure Ranges Available:
3, 5, 10, 15, 30, 50, 100, 200, 300 and 500 psig.
Custom ranges also available.

Maximum Pressure Display Resolution:
0.0001 psig (range dependant)

Vacuum Ranges Available:
-15 psig

Vacuum Display Resolution:
0.0001 psig (range dependant)

Repeatability: 0.03% of Full Scale

Pressure/Vacuum Units of Measure:
psig, mbar, inHg, mmHg, inH2O, mmH2O, kPa,
kg/cm² (user selectable)

Mass Flow Ranges Available:

10, 50, 200, 500, (15 psig max)
5000, 20000 sccm (60 psig max).
Custom ranges also available

Maximum Mass Flow Display Resolution:
0.01 sccm (range dependant)

Mass Flow Sensor Repeatability:
0.5% of Full Scale

Mass Flow Units of Measure:
sccs, sccm, scch, smls, smlm, smlh, sls, slm, slh
(user selectable)

Base Unit Dimensions:
8.9” W x 15.0” D x 10.8”H”
(216 mm W x 381 mm D x 267 mm H)

With Expansion Chassis:
8.9” W x 16.2” D x 14.8”H”
(216 mm W x 411 mm D x 376 mm H)

Power Supply:
100-240VAC 50/60Hz (Auto Sensing & Switching)

5.0.2 Standard Features

- High Performance 24 Bit Analog to Digital (A-D) Converter
- Leak Rate in sccm or ΔP (pressure change)
- True Volumetric Calibration Capable (Compensation & Calibration)
- Low System Volume for Maximum Sensitivity
- Dual USB Communication Ports (Front & Rear)
- RS-232 Serial Communication Port
- Remote Control of Tester via RS-232 Serial Commands (including Program Select)
- Program Linking and Jumps (Pass/Fail Selectable)
- Program Backup via USB Flash
- Real Time Clock
- Internal Test Data Storage of Last 250 Cycles (Each Test Channel)
- Test Data Downloading via USB Flash
- Programming Protection by Security Key (CFR21 Part 11 Compliant)

5.0.3 Optional Features

- Additional Expanded I/O: 8 Configurable Inputs16 Configurable Outputs
- Additional Regulator
- Bar Code Reader
- Continuous Fill
- Coupling Ports (up to 8 and can accommodate up to 4 four-way valves)
- Data Statistics & Histograms
- Downstream Sensor
- Electronic Programmable Regulator
- Ethernet/LAN Communication Port
- Extended Chassis
- Fast Fill
- Foot Switch
- High Pressure
- High-Pressure Coalescent Filter
- Manual Ramp for Electronic Regulator
- Mist Separator and Filter
- NIST Traceable Leak & Flow Orifices
- PLC Interface with Remote BCD Program Selection (11 Defined Inputs / 11 Defined Outputs)
- Power Line Filter
- Vent Delay on Downstream Sensor

5.0.4 Digital I/O Pin Assignments

Digital I/O is an optional feature. The connector may be found in the location shown on page 10.

The inputs are single-ended.

The outputs are 24V dry-contact relay operated.

Function	Pin No.
START (+)	1
START ENABLE (+)	20
RESET (+)	2
BCD 0 (+)	21
BCD 1 (+)	3
BCD 2 (+)	22
BCD 3 (+)	4
BCD 4 (+)	23
BCD 5 (+)	5
BCD 6 (+)	24
BCD 7 (+)	6
INPUTS RETURN (-)	25
PASS 1 +	7
PASS 1 -	26
FAIL 1 +	8
FAIL 1 -	27
PASS 2 +	9
PASS 2 -	28
FAIL 2 +	10
FAIL 2 -	29
PASS 3 +	11
PASS 3 -	30
FAIL 3 +	12
FAIL 3 -	31
PASS 4 +	13
PASS 4 -	32
FAIL 4 +	14
FAIL 4 -	33
READY +	15
READY -	34
EOC +	16
EOC -	35
ALARM +	17
ALARM -	36
N/C	18
N/C	37
N/C	19

5.0.5 Converting Pressure to Flow Rate

You can determine the leak rate in flow units (cubic centimeters per minute) based on the pressures (**P1** less **P2**) measured by Sprint iQ. In a pressure decay test, Sprint iQ holds the pressure drop on the main digital readout-large numerals in the center of the LCD. The pressure drop is the delta pressure (P) in the formula.

Delta time (t) is the test timer value set in Sprint iQ's pressure decay program (provided the test passes). Because this timer is set in seconds, merely divide by 60 to get the delta time in minutes.

Volume is the part volume plus Sprint iQ's internal test circuit (generally between 5.0 cubic centimeters and 15.0 cubic centimeters depending on model) plus the volume of connections between Sprint iQ's test port and the product. The total volume (for our example) must be in cubic centimeters.

Atmosphere is the barometric pressure in pounds per square inch (roughly 14.7 psi at sea level). This number changes with weather conditions.

5.0.6 Concepts Applicable to Testing

Pressure

In physics, pressure is a force measured in terms of its distribution over an area of an opposing force. This is expressed as force (F) divided by unit area (A) of the surface area to which the force is applied. Air pressure most commonly refers to a force exerted uniformly in all directions. Force X Area = pressure.

Absolute pressure is pressure measured with respect to zero pressure (a very high vacuum)

Gauge pressure is pressure measured with respect to surrounding air pressure (the pressure exerted by the weight of the atmosphere).

Barometric pressure is the surrounding pressure caused by the atmosphere. At average sea level, barometric pressure is about 14.7 pounds per square inch, or 29.9 inches of mercury. This is equivalent to 101.3 Kilopascals.

Negative Pressure (Vacuum)

A vacuum can be defined as a volume of space that contains no matter. For practical purposes, this means a volume where as much matter as possible has been removed. A perfect vacuum does not exist even in the depths of space. Any given volume will probably contain one or more particles of matter or one or more units of energy, which is the equivalent of matter (relativity). Even a vacuum with no measurable energy level is only a "virtual" vacuum.

Air Composition

The atmosphere is composed almost entirely of oxygen and nitrogen in their diatomic forms (two atoms bound together by chemical forces). Diatomic nitrogen makes up about 78%

of the total molecules in the atmosphere. Diatomic oxygen represents nearly 21%. The inert noble gas, argon, accounts for about 0.9%, and the remaining 0.1% is composed of many trace gases, the most significant being carbon dioxide and water vapor. Carbon dioxide makes up only 325 parts per million of the atmosphere by volume. Water vapor is present in highly variable quantities ranging from 0 to 4% by volume.

Air Density

If the atmosphere were like water and incompressible, pressure would decrease uniformly as you went up. In reality, the atmosphere is compressible and density (mass per unit volume) is proportional to pressure. This relationship, called Boyle's Law, implies that density decreases with height in the atmosphere: As height increases, less mass remains above a given point; therefore less pressure is exerted. At sea level, the density of air is about 1 kg per cubic meter (8 oz. per cubic foot). Both pressure and density decrease by about a factor of 10 for every 16 km (10 miles) increase in altitude.

Density does not depend solely on pressure. For a given pressure, density is inversely proportional to temperature. This relationship, known as Charles' Law, implies that the depth of an air column bounded by two constant-pressure surfaces will increase as the temperatures in the column decreases.

Density varies mostly with pressure over large vertical distances; at constant height, pressure variation with temperature becomes important. In the low atmosphere, air is heavy, with a stable mass of roughly one kilogram per cubic meter (1 oz/cubic foot). A room of 500 cubic meters (650 cubic yards) thus contains 0.05 metric ton of air. At an altitude of 3 km (2 miles), however, density is 30% less than at sea level.

This difference in air density can cause variations in flow readings from one location to another when elevations are quite different and no corrections are made.

Sprint IQ measures true air flow in units standardized to 29.92 inHg (14.68 psi) at 20 degrees C. Although the Sprint IQ's measurements are accurate and traceable to NIST standards, flow readings could be different if the tester is used at drastically different altitudes. This is not a tester fault; rather, conditions have changed and Sprint IQ measures this difference. At a high altitude, air is less dense than air at a lower elevation. When compressed to the same relative pressure, the air will exhibit a density shift when compared with air compressed to the same relative pressure at a lower level.

Difference in air density is the primary reason users can observe slightly different results when temperature and gauge pressures are identical. For this reason, it is important to establish all test parameters at the same altitude and under the same conditions in which the tester will be used.

Compensation may be necessary to reconcile air density variations between the two locations if measurements are made at different altitudes.

Fluids vs. Solids

The distinguishing feature of a fluid (gas or liquid), in contrast to a solid, is how easily the fluid can be deformed. If a shearing force, even a very small force, is applied to a fluid, the fluid will move and continue to move as long as the shear acts on it. For example, the force of gravity causes water poured from a cup to flow. Water continues to flow as long as the cup is tilted. If the cup is turned back up, the flow stops because the gravitational force is then exactly balanced by force of the cup wall.

Gas vs. Liquid

Unlike liquids, gases cannot be poured from one open container into another, but they deform under shear stress just the same. Because shear stresses result from relative motion, stresses are equivalent whether the fluid flows past a stationary object or the object moves through the fluid.

Although a fluid can deform easily under an applied force, the fluid's viscosity creates resistance to this force. The viscosity of gases, which is much less than that of liquids, increases slightly as the temperature increases, whereas that of liquids decreases when the temperature increases. Fluid mechanics is mostly concerned with Newtonian fluids, or those in which stress, viscosity, and rate of strain are linearly related.

Pressure and Density

Pressure and density are considered mechanical properties of the fluid, although they are also thermodynamic properties related to the temperature and entropy of the fluid. For a small change in pressure, the density of a gas is essentially unaffected. For this reason, gas and all liquids can be considered incompressible. If density changes are significant in flow problems, however, then the flow must be considered compressible. Compressibility affects results when the speed of the flow approaches the speed of sound.

Fluid Flow-Real Fluids

Equations concerning the flow of real fluids are complex. In turbulent flow, the equations are not completely known. Laminar flow is described by the Navier-Stokes equations, for which answers can be derived only in simple cases. Only by using large computers can answers be derived in more complex flow situations. Experimentation is still important for fully correlating theory with actual flow.

Laminar vs. Turbulent Flow

When flow velocity increases, the flow becomes unstable, and changes from laminar to turbulent flow. In turbulent flow, gas particles start moving in highly irregular and difficult-to-predict paths. Eddies form and transfer momentum over distances varying from a few millimeters, as in controlled laboratory experiments, to several meters, as in a large room or other structure. Equations for turbulent flow are more complex than the formulas for laminar flow. For most answers, they require empirical relations derived from controlled experiments.

Whether a flow is laminar or turbulent generally can be determined by calculating the Reynolds number (Re) of the flow. The Reynolds number is the product of the density (designated by the Greek lower-case letter rho {ρ}), a characteristic length L, and a characteristic velocity v, all divided by the coefficient of viscosity (designated by the Greek lower-case letter mu {μ}): **Re = (ρ)LV/μ**

Reynolds Number (Re)

The Reynolds number is dimensionless, a pure number. As long as Re is small, the flow remains laminar. When the Reynolds number becomes greater than a critical value, the flow becomes turbulent. With rho, L, and mu constant, Re varies simply as velocity changes. For flow in smooth round pipes, critical value is about 2,000, with L equal to the diameter of the pipe.

Pascal’s Law

In 1653, Blaise Pascal came up with the idea that in a fluid at rest, the pressure on any surface exerts a force perpendicular to the surface and independent of the direction or orientation of the surface. Any added pressure applied to the fluid is transmitted equally to every point in the fluid. Pascal used his idea to invent the hydraulic press. Pascal's principle is often used in devices that multiply an applied force and transmit it to a point of application. Examples include the hydraulic jack, and the pneumatic cylinder.

Gas Laws

The actions of gases under varying conditions of temperature, pressure, and volume can be described and predicted by a set of equations, or gas Laws. These Laws were determined by measurements of actual gases and are valid for all substances in a gaseous state.

Measurements on gases were first published by Robert Boyle in 1660. He figured out that if an enclosed amount of gas is compressed until it is half its original volume while the temperature is kept constant, the pressure will be doubled. Quantitatively, Boyle's Law is: PV = Constant, where the value of the constant depends on the temperature and the amount of gas present.

Relationships between the temperature of the gas and its volume while keeping the pressure unchanged were studied by Jacques Charles. He saw a steady increase in the volume as the temperature went up, finding that for every degree Celsius rise in temperature, the gas volume increase by 1/273 of its volume at zero degrees C.

Charles's Law and Kelvin Temperature

Charles's observations led to the absolute (Kelvin) temperature scale, since the gas, according to the equation, would have zero volume at -273 degrees C. The absolute temperature scale was defined by Kelvin so that absolute temperature equals negative 273 degrees C and each absolute degree is the same size as a Celsius degree. The modern value for absolute zero is -273.15 degrees C. This temperature scale allows Charles's Law to be written V/T = Constant, where V is the volume of the gas, T is the temperature on the absolute scale, and the constant depends on the pressure and the amount of gas present.

In 1802, Joseph Gay-Lussac played around with the relationship between pressure and temperature and came up with an equation a lot like Charles's Law: P/T = Constant.

Generalized Gas Law

We can combine Boyle's, Charles's, and Gay-Lussac's Laws to express this generalized gas Law: **PV/T = Constant**, where the value of the constant depends on the amount of gas present and t is the absolute (or Kelvin) temperature.

Ideal Gas Law

The Ideal Gas Law can be written in a slightly different manner from the Generalized Gas Law: **PV/T = nR**, or **PV = nRT**. When written this way, it is called the Ideal-Gas Law. R is the gas constant, and n is the number of moles of gas. The gas constant can be examined experimentally as R = 0.082 liter atm/Kelvin moles. Knowing R, the fourth variable can be evaluated if any three are known.

The gas Laws are valid for most gases at moderate temperatures and pressures. At low temperatures and high pressures, gases deviate from the above Laws because the molecules are moving slowly at low temperatures and they are closer together on the average at higher pressures.

Ideal vs. Real Gas

Gases are typified as ideal or real. The ideal gas follows certain gas Laws exactly, whereas a real gas closely follows these Laws only at low density. Ideal behavior can be ascribed to a real gas if its molecules are separated by very large distances, so that intermolecular attraction is negligible.

Adiabatic Process

(ad-ee-uh-bat-ik)

Adiabatic compression and expansion are thermodynamic processes in which the pressure of a gas is increased or decreased without any exchange of heat energy with the surroundings. Any process that occurs without heat transfer is called an adiabatic process.

The adiabatic compression or expansion of a gas can occur if the gas is insulated from its surroundings or if the process takes place quickly enough to prevent any significant heat transfer. This is essentially the case in a number of important devices, including air compressors.

An adiabatic expansion is usually accompanied by a decrease in the gas temperature. This can be observed in a common aerosol can, which becomes cold after some compressed gas is released. The reason for the temperature drop is that the gas is released too quickly to absorb any significant heat energy from its surroundings. Work performed in expanding the released gas drains some internal energy of the gas still in the can, making it colder. After the can metal becomes cold, however, the process is no longer adiabatic.

In a similar fashion, adiabatic compression usually increases the temperature of a gas, since work is done on the system by the surroundings. For example, when air is pumped into an automobile tire, the air temperature rises as a result of adiabatic compression.

5.0.7 Terminology Reference

Abort a test, how to: Press the red STOP button during the test. An aborted test will register on the Tested and Rejects counters.

Atmosphere (1): In this guide, atmosphere means room air pressure. Atmospheric pressure is nearly synonymous with barometric pressure-an external force pushing on all sides of every object on earth's surface. During a flow test, product being tested must flow into atmosphere, which causes a resistance to flow called backpressure. Room atmosphere can change due to fluctuations in air conditioning or changing weather conditions.

Atmosphere (2): The word atmosphere can refer to a unit of measure equal to pressure at average sea level. By convention, one atmosphere equals 14.7 psi. To say a test was taken at one atmosphere means the test was made at (or converted to) average sea level.

Barometric Pressure: Also called atmospheric pressure. The force of air pressing down on the earth. Barometric pressure changes with elevation and weather conditions. Sprint's regulator compensates for changes in barometric pressure to provide a constant relative output.

Bulkhead Fitting: A connection passing through a panel or enclosure. Standard bulkheads on the front have a #10 by 32 pitch machine thread.

Burst Test: One of Sprint iQ's possible operating modes in addition to pressure decay and flow. A burst test slowly fills a product through a flow valve set by users. After the burst, pressure rapidly drops to near zero. Sprint iQ captures the pressure immediately before the product ruptures or in some way opens to atmosphere. Burst mode is useful for testing pop-off valves, package seals, or devices that open to atmosphere after reaching a certain pressure.

Cal Value: Cal Value = Pressure change during the leak test step with a calibrated leak master – the Comp Value.

Calibration: Comparison of a device (such as Sprint iQ) to a standard that is in turn calibrated to an even more accurate standard.

Calibration Data: Values entered into Sprint iQ through software calibration.

Calibration Menu: Calibration allows comparison for Sprint iQ to pressure or flow standards. The calibration screen shows Sprint iQ's actual reading and the pre-programmed target value the technician compares to the pressure or flow standard. Calibration should be conducted only by qualified technicians who have proper training and resources to calibrate Sprint.

Calibration Table: Technicians don't need to adjust potentiometers, dipswitches, or other electrical components to calibrate Sprint. All calibration is done by making adjustments to Sprint iQ's sensor linearization tables.

Comp Value: Pressure change during the leak test step with a non-leaking master

Concurrent: Testing multiple ports or multiple parts at the same time is known as concurrent testing. If the tester has multiple test ports and tests them all at the same time, it is called a concurrent tester. See Sequential.

Contrast: The contrast of the LCD can be adjusted for the best viewing using the Display Contrast setting in the Setup Menu.

Counters: Sprint iQ records the total number of tests performed (both pass and fail) and number of rejects (fail only). Running totals are displayed to operators in the tested and reject boxes on the run display. Counters may be cleared from the Program Mode Data Menu.

Coupling Port: The coupling port supplies air pressure to product sealing fixtures or other external pneumatic components.

Coupling Pressure: The air pressure supplied to external fixtures. Coupling pressure must be greater than the test pressure and the same as the incoming line pressure unless additional pneumatic components are added.

Coupling Time: A delay timer used to apply a clamp or seal to product under test before the product is filled with air. Coupling time gives fixtures enough time to seal product before Sprint iQ applies test pressure.

Crack Test: A crack test is setup to measure the pressure at which a product, like a check valve, opens and allow air to flow through. It is used with parts that do not open quickly enough to cause a drop in the upstream pressure. An optional downstream sensor is required to measure a device that opens very slowly. Crack testing differs from burst testing because the product does not suddenly drop to zero pressure as in a burst test.

Creep Test: A creep test is setup to verify that a part can withstand a minimum proof pressure. The minimum burst and maximum burst values are set to the same pressure. This tells Sprint to redefine the pass/fail criteria. If the ramping pressure during the test reaches this value then the part is considered good.

Decay Test: A test type which may be either a pressure decay or vacuum decay test.

Decay: The amount of pressure change a product can sustain during a test period before going out of an established tolerance. This applies to both pressure and vacuum decay testing.

Electronic Regulator: An optional device that automatically adjusts the test pressure to a preset value. Multiple test programs with multiple test pressures may be linked together if this option is installed. It also provides a way to avoid having the operator manually adjust the pressure for different test pressures. (Also see “Electronic Programmable Regulator” on page 111.

Evacuate Time: The time duration to apply a vacuum to the test product in tests such as a decay test (vacuum).

Event: The instant pressure drops below the event value during a burst or creep test. Sprint iQ monitors pressure during a burst test or creep test and holds the maximum pressure value measured before the event (pressure drop) occurred.

Factory-Configured Programs: Uson ships Sprint iQ with a few programs already set up out of the 100 positions available to hold test programs. These programs can be retained, modified, or replaced as desired.

Fail Light: The fail light for a channel turns on whenever a test exceeds established parameters. The light is extinguished when the next test starts.

Fill Time: The time duration to apply test pressure to the product in tests such as a decay test (pressure).

Firmware: The set of instructions stored in programmable read-only memory (PROM) that tell Sprint how to operate. Firmware cannot be altered by the customer.

Firmware Version (finding): The version of firmware running Sprint iQ is briefly displayed in the startup screen when the tester is first turned on and is also visible on the Program Mode screen.

Fixturing: A fixture is a device connected externally to Sprint iQ. Fixtures can be mechanical, electrical, pneumatic, or combinations of all. Typical fixtures are pneumatic clamps that seal products during a pressure decay or flow test. Sprint can supply air from the coupling port to operate pneumatic fixtures. Customers must specify at order whether they want coupling pressure to be line or test pressure. Many fixturing options are possible.

Flow Control: Sprint iQ has a built-in flow control to provide a slow pressure increase (ramp up) needed for burst and crack testing. Users can precisely set the flow control for the exact pressure build-up required for the product to be tested. After the flow control is set for a particular product, the needle valve need not be adjusted again.

Flow Master: A measuring instrument or certified restrictor that can be connected to Sprint iQ as part of a flow calibration. The flow standard must have adequate accuracy, stability, and repeatability needed to calibrate Sprint iQ. The flow standard must have current calibration documentation if the customer requires accuracy traceability.

Flow: The amount of air passing through an object measured in cubic centimeters or liters per time period (minute, second, or hour).

Flow Transducer: A device that converts gas flow into electrical signals. The type of transducer used in Sprint is a mass flow transducer, which is both accurate and compensated for room temperature influences.

Flow Test: A flow test involves pushing air through a product at a set pressure and measuring the resultant flow sensor. Flow testing can be used in two ways:

(1) Flow Leak Detection: Product is filled with air at a set pressure and then sealed from atmosphere in a pressure decay test. Any flow above zero indicates a leak.

(2) Flow Measurement: Air is pushed through a product at a set pressure and allowed to flow to atmosphere. The amount of air movement through product is measured by the flow sensor. Sprint iQ's digital readout shows flow rate in units that can be selected by the customer.

Gage Pressure: A force referenced to barometric pressure. Sprint uses a gage regulator to keep the pressure constant as barometric pressure changes.

Gross Leak: A leak that causes a drop below the negative pressure error during the stabilization phase. Typically, when a product under test has a gross leak, pressure cannot build high enough to reach test pressure.

If Sprint iQ indicates a gross leak in good products, a larger pressure error value may be needed. This is often the case when testing large product or products constructed of flexible materials. See Pressure Error.

Help: Get technical help from Uson by calling **+1 281-671-2222**. Help is available during normal business hours in the Central Time Zone of the USA.

Interface Communication: between Sprint and a peripheral device such as a PLC, computer or printer. Sprint has many interface options such as an I/O port for discrete communication, an ethernet port, and serial port for test result output. The serial port uses a serial protocol known as RS-232 to communicate. The interface is setup in the Serial Port Menu reached through the Hardware Menu.

I/O (Input/Output): Devices or connections used by computers and Sprint iQ to communicate with other devices such as Programmable Logic Controllers (PLCs). See PLC

Jump: In the Test Parameter Menu use the Jump Menu to link programs in a variety of ways.

Keypads: The six blue buttons on Sprint iQ's front panel used to enter program values and other setup information.

LCD: Abbreviation for liquid crystal display. Sprint iQ's display is an LCD device that provides setup prompts, menu options, test results, and other system information.

Leak Rate: A pressure drop over time can be stated as a leak rate. For example -0.02 psi per second is a leak rate. A leak rate can also be stated in flow units, such as 4 cc/minute.

Leak Test: See Pressure Decay Test, Flow Test.

Line Conditioner: An optional device external to Sprint iQ that filters out noise from the AC power line input. Line conditioners are especially useful when Sprint iQ is connected to automated machines that produce electrical noise.

Linked Programs: Two or more programs can be linked (consecutively connected) to perform multiple actions during a single test cycle. For example, a flow program can be set to follow a decay program so that when the operator presses the START switch, Sprint iQ runs through a flow test then goes to a decay test. If the product goes out of parameter at any point in either test, the fail light turns on and the test ends.

Lockout Keyswitch: This keyed switch locks out operators from Sprint's setup and calibration functions. The only way to access programming screens is to use the key and turn the switch to program (horizontal) position.

Main Digital Readout: In the center of Sprint iQ's run display screen, the main digital readout is visible when Sprint is in run condition. This readout shows the pressure and flow values during pressure decay, flow, and burst testing. The way the main digital readout functions varies with each testing mode.

Measurement Units: See Units of Measure.

Menu: A menu is a list or set of options or program settings.

Modes: Sprint has many possible test modes: i.e. pressure decay, flow, burst, etc. Sprint shows the current mode or test type in the test mode box on Sprint's run display.

Occlusion Test: Occlusion testing is used to test products open passages by trapping pressure inside a product and then measuring an expected pressure loss.

Operator: The person who attaches products to Sprint, presses the START button, and monitors the test. For the purposes of this guide, the operator is separate from the user. Users typically handle Sprint's setup and programming.

Pass Light: Sprint's green indicator. The pass light turns on after the tester completes a test that remains within the established parameters.

PLC: Abbreviation for Programmable Logic Controller. Industrial-strength computers designed to accept analog inputs and to provide output for process control. PLC's are used in a variety of automated control situations. Sprint can send discrete test results to and accept signals to tell

Sprint when to begin a test from a PLC through the tester's I/O port. Sprint can also send quantified test results over its RS-232 output. See I/O

Pressure Decay: Also called pressure drop or delta pressure. The pressure change from the first measurement to the last measurement made during the test phase of a test. See Reject Level

Pressure Decay Test: Pressure decay testing is used to test products for leaks by trapping pressure inside a product and then measuring pressure loss. The abbreviation P Decay is often used in this guide to refer to pressure decay.

Pressure Error: Pressure setpoints above and below test pressure. One pressure error (a plus and minus value) is used by Sprint to insure that a valid test is performed on each product. A lack of test pressure that causes a drop in pressure to exceed the negative pressure error value during the fill period of product testing causes Sprint to stop testing and display the error in the status box. If test pressure is accidentally increased, Sprint also shows the error in the status box on the run display.

Pressure Regulator: The Sprint iQ can be configured to support up to 3 regulator inputs depending upon the model type and option configurations. (Also see "Electronic Programmable Regulator" on page 111.)

The regulator inputs are defined as:

Main: Default input which is used as the standard common regulated supply for all test channels on a sequential tester and common regulator concurrent tester or channel 1 for the independent regulator concurrent tester. The regulated supply can be a manual or electronic pressure regulator, a vacuum regulator supplied by an external or internal vacuum supply or vacuum venturi controlled by a manual or electronic pressure regulator. Sensor 1 configuration will define the operating range of the regulated supply input.

Auxiliary: The second regulated supply which is fitted as an option. This allows the user to select a second common manual regulated supply for the fast fill option or as an alternative test pressure for all test channels within a sequential tester and common regulator concurrent tester or as channel 2's test pressure for the independent regulator concurrent tester. The regulated supply can be manual pressure regulator, a vacuum regulator supplied by an external or internal vacuum supply or a vacuum venturi controlled by a manual pressure regulator.

Sensor 2 configuration will define the operating range regulated supply input for the independent regulator concurrent tester and Sensor 1 configuration for the other tester types.

Venturi (or Auxiliary 2), the third regulated input is reserved for a vacuum input when pressure and vacuum tests are required. The regulated supply can be a vacuum regulator supplied by an external or internal vacuum supply or a vacuum venturi controlled by a manual or electronic pressure regulator.

Pressure Standard: A precision measuring instrument that can be connected to Sprint as part of pressure or flow calibration. The pressure standard must have the required accuracy, stability, and repeatability to measure Sprint’s output. The pressure standard must have current calibration documentation if the customer needs to prove accuracy traceability.

Pressure: The relative force of a compressed air or gas. Sprint iQ is generally configured to use PSIG, which is the force of compressed gas relative to barometric pressure.

Pressure Transducer: An electro-mechanical device (also called a sensor) that converts pneumatic pressure into electrical signals. Sprint's pressure transducers are rugged, accurate, repeatable, and have a very low internal volume.

Programming: Entering values to setup the tester. Also called setup or data entry.

Program: Data (such as test pressure, test time, and reject levels) entered by the user and stored in nonvolatile RAM. A program is setup in Sprint's parameters screen. When multiple programs are linked, the programs become a test cycle. See also Stored Programs.

PSIG: Pounds per Square Inch Gauge. A unit of measurement for air pressure measured with respect to local atmospheric pressure.

PSN Ratio: Pneumatic Signal/Noise Ratio. The larger the PSN Ratio, which is the Cal Value divided by the Comp Value, the more repeatable the test will be. The PSN Ratio can be in the range of .2 to .25 if +/- 10% test repeatability is sufficient.

Ramp Up: To slowly increase pressure by routing test pressure through the flow control valve located on the back of Sprint. Various ramp rates can be established by adjusting Sprint's built-in flow control.

Reject Minimum and Reject Maximum: The amount of pressure change allowed in a test. These values are set in the Reject Limit menu under the Test Parameters menu.

Some tests require both setpoints to be set (providing a window or zone for test evaluation) while others require only one (test outcome depends on if the level is reached or passed). See page 38.

Rise Test: A test type which can be either a pressure rise or vacuum rise test. The results are expressed as a positive value if the pressure change is in the expected direction or negative if otherwise. E.g., a typical pressure decay test will have a positive value consistent with a positive pressure delta where the pressure is actually decreasing.

RS-232: A serial communications protocol used by most computers and computer peripherals. Sprint iQ uses an RS-232 protocol to send test result data to printers and computers.

Run: When the lockout key is in the vertical position, Sprint is in Run Mode. Sprint iQ is set to run when used in production testing. The only other keyswitch condition is Program Mode (lockout key in horizontal position).

Run Display: The only screen visible when the lockout key is in run (vertical) position. This display is visible to the operator during testing.

Run/Program Switch: See Lockout Keyswitch.

SCCM: Abbreviation for Standard Cubic Centimeters per Minute. This is a flow measurement standardized to 68 degrees Fahrenheit and 14.7 psi (average sea level)

Security key: A USB device that unlocks capabilities which may be available for the tester.

Sensor: Sprint iQ uses two kinds of sensors-a pressure sensor and a flow sensor. As an option, remote sensors can be connected to Sprint for automated processes.

Sequential: Testing one test or one part after another is known as sequential testing. If the tester has multiple test ports and test them one at a time in a sequence, it is called a sequential test. See Concurrent

Setpoint: A programmable threshold value (usually a minimum and maximum value) used to establish a testing tolerance.

Sprint iQ: In this guide, the word Sprint iQ refers to the base-model Sprint iQ air tester. Your particular tester will probably not have all the options explained in this owner's guide.

Stab.: Abbreviation for stabilization. A time interval following fill phase that allows product to settle before Sprint starts the measurement phase. Longer stabilization times are often required in products constructed of flexible materials.

Start Switch: The green pushbutton.

Startup Screen: The first screen that briefly appears on Sprint's LCD when the power is switched on. This screen briefly shows the version of firmware running the tester.

Stop Switch: The red pushbutton. Pressing this switch will always abort a test in progress.

Stored Programs: A set of instructions (parameters) that can be set by the customer to run a variety of tests. There are a total of 100 programs available. Users can alter stored programs to meet specific product testing needs. Programs are configured in Sprint iQ's Test Parameters Menu and are kept in non-volatile RAM.

Stored Programs, changing from one to the other: In run condition, press the ENTER keypads to go to the Run

Options Menu. Change the current program to another stored program and press Enter to save the new selection.

Supply Air: Sprint’s standard fitting is a 1/8 inch female NPT bulkhead. Air must be clean, dry, and free of oil. Unless the tester is a custom, the maximum supply pressure must not exceed 150 psig.

Test Parameter Menu: This menu is the first menu highlighted when the Keyswitch switch is turned to Program mode. This is the primary menu for entering the values that define the test and how it is to be conducted.

Target: A pre-programmed number that Uson stores in firmware used to calibrate Sprint iQ’s pressure and flow sensors. The target value is matched to a pressure or flow standard to create a lookup table for sensor linearity adjustment.

Test Circuit: The pneumatic tubing, fittings, valves, and sensors that make up the internal air passages. The volume of gas trapped inside the pressure decay test circuit is about 6.5 cubic centimeters on the LC-PO single channel model.

Test Cycle: A test cycle is all Sprint-controlled testing activities that occur from the time the START switch is pressed to the time the operator removes the tested product. One test cycle can have multiple tests by linking programs in Sprint’s parameters screen. Multiple tests in one cycle is sometimes called a test series.

Test Phases: Each testing mode (decay, flow, and burst) has individual phases or intervals of testing. Pressure decay has four possible time intervals that can be set: coupling, fill, stabilization, and test. A flow test has three phases: coupling, fill and test. A burst test has just two possible phases: coupling and test.

Test Port: The bulkhead fitting (or fittings) on Sprint iQ's front panel. The product to be tested is connected to the test port. From the test port, Sprint iQ can supply positive pressure or vacuum for a variety of leak and flow tests. Customized Sprints could have multiple test ports. See Bulkhead.

Test Pressure: A positive value indicating the level of air pressure used to inflate the product under test. Test pressure is set by adjusting the air regulator on the back of Sprint iQ. Test pressure can only be set if Sprint iQ has supply air connected and the output port is blocked with a leak-tight cap. This limitation can be overcome with an electronic regulator. See Electronic Regulator

Test Vacuum: A negative value indicating the level of vacuum applied to the product under test.

Timers: Sprint iQ uses microprocessor timers to establish time intervals for a variety of test functions. Time values are set in the parameters screen to control coupling time, fill time, stabilization time, and test time. Timers are calibrated in seconds. See Parameters Screen

Units of Measure: Sprint iQ can display pressure, flow, and time in several user-selectable measurement units. Changing units of measure if made through the Setup Menu which is accessed from the initial Program Mode menu.

User: For purposes of this guide, the user is the person who sets up and enters test parameters into the Sprint iQ. It is the operator who handles the day-to-day product testing with the Sprint iQ.

Vacuum Error: A negative quantity indicating the magnitude of the vacuum.

Valves: Sprint iQ contains modular solenoid valves that direct the flow of air through the measurement circuits. The number, type, and arrangement of valves in a Sprint tester is dependant on the model and configuration.

Vent: After Sprint iQ completes a decay test, a valve can be activated to open the product and Sprint's internal test circuit to atmosphere. The action of releasing pressure to atmosphere is called vent. If vent is not required (for instance, if you want to unplug product to vent pressure), set Vent to No.

Venturi, Electronic: This option is used to produce a vacuum level and requires an inlet pressure between 55.0 to 101.5 psi depending upon the vacuum required. This option is only available when the Fairchild 120 psi regulator is used as the Main test regulator. To support this option the pneumatic arrangement is configured to use the pneumatic regulator output via the main regulator selection valve when pressure is required by the test or connects output to the venturi input when vacuum is required by the test.

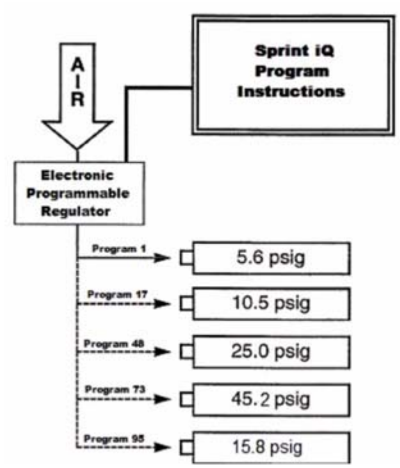
5.0.8 Electronic Programmable Regulator

When conducting multiple tests using different test pressures, users face the problem of constantly adjusting manual pressure regulators. A cracking pressure test (often used for valve testing) frequently requires multiple ramp rates. Operators must adjust manual flow controls to various ramp rates needed for the different tests. Manual pressure controls are subject to operator error when setting test pressure. And inadvertently bumping the regulator control is a possibility when using the equipment in production settings.

Sprint iQ's Electronic Programmable Regulator option is a sophisticated electro-pneumatic device programmed by setup personnel to supply exact test pressures. The Electronic Programmable Regulator can also be set to slowly increase pressure over time. This provides a variety of consistent ramp rates often used in burst and crack (valve) testing.

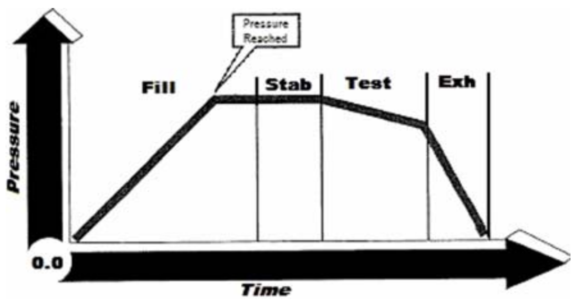
Also, because the regulator is programmed using Sprint iQ's security key, it can supply different test pressures or ramp rates for each of Sprint iQ's stored programs and no operator adjustment is needed (or possible) without possession of the security key.

How it Works



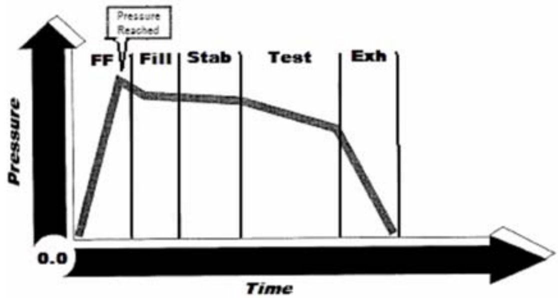
1. Sprint iQ is set to Program mode.
2. In the Program setup screen, setup personnel digitally enter test pressure values using Sprint iQ's normal programming methods.
3. Unique test pressures can be entered for each of Sprint iQ's stored programs. As many as 100 different test pressures can be entered.
4. When in Run mode, the Electronic Programmable Regulator automatically goes to the set test pressure to provide the desired pressure or ramp rate for one or multiple parts.

Test Pressure



Test Pressure is the pressure to which Sprint iQ inflates the test part before beginning to look for a pressure drop over time. The Electronic Programmable Regulator automatically adjusts to achieve the target test pressure.

The Electronic Programmable Regulator can also be used instead of the Fast Fill option.



A program preceding the actual test program is created which contains no active test limits but is set to a target pressure higher than the actual leak test pressure. This higher pressure fills the test part faster (equivalent to a Fast Fill). After this step is completed, the first program links to the actual test program with the target test pressure.

Ramp Rate

Ramping is used in burst, crack and creep testing. Ramp Rate is an increase in pressure over time. Sprint iQ's Electronic Programmable Regulator precisely controls the ramping pressure.

Often, cycle time can be saved and burst or crack event sensitivity increased by quickly jumping to a minimum starting pressure (without ramping) below the typical pressure where a burst or crack event is expected. A ramp can then be started until the event occurs. The Electronic Programmable Regulator option is ideal for this purpose (not possible with a standard Burst or Crack equipped tester where pressure must start at or near zero pressure).

To program a ramp, the user first enters a starting pressure and then a rate in pressure units per second. For example, if 45 psig ramp starting pressure and 10 psig/s ramp rate is entered, at the start of the test cycle, pressure will immediately go to

45 pounds per square inch pressure then increase at a rate of 10 pounds per square inch every second.

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