Sentinel MH

User Manual

v1.0

IMPORTANT INFORMATION

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The illustrations, charts, and layout examples shown in this manual are intended solely to illustrate the text of this manual. Because of the many parameters and requirements associated with any particular installation, Cincinnati Test Systems cannot assume responsibility or liability for actual use based on the illustrative uses and applications.

CAUTION **–** When you see this warning symbol on the product, refer to the instruction manual for information before proceeding.

CAUTION **–** To avoid personal injury due to electric shock, disconnect all power services before servicing.

If this instrument is not used according to the instructions of this manual, the protection provided by this equipment design may be compromised.

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Table of Contents

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Chapter 1 – Introduction

This chapter explains the external pneumatic and electrical connections and introduces the simple menu structure and navigation of the instrument.

Thank you for purchasing the Sentinel MH™ precision leak test instrument. The Sentinel MH is capable of testing using a variety of pre-packaged test algorithms designed to get you testing as quickly and easily as possible. Let's get started!

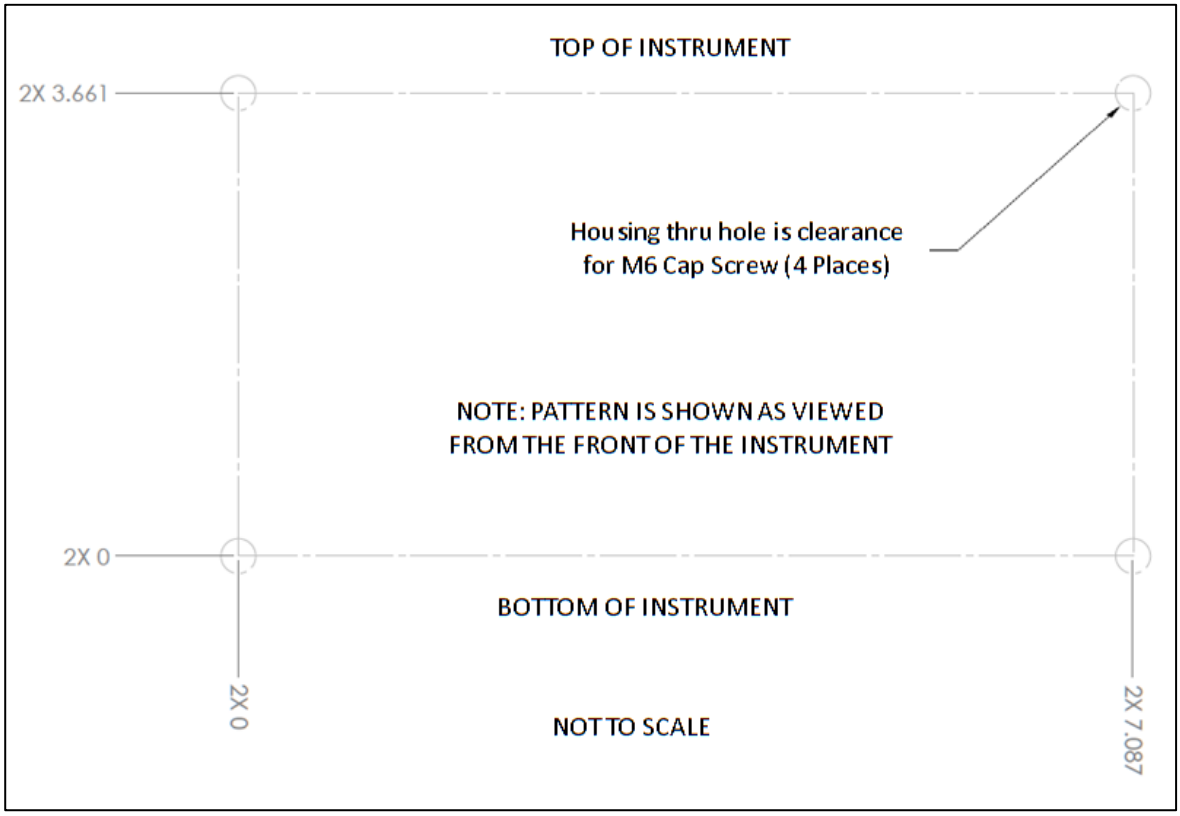
Unpacking

Carefully remove the instrument from the shipping carton. Locate the DC power connector supplied with the instrument. The test port should have a quick connect test port with a Self-Test cap. Alternatively, you may install any suitable 1/4" NPTM fitting into the manifold test port. If this is not a standard instrument, see the print packet that shipped with your instrument for the proper thread specifications.

Instrument Attachment & Clearance

There are four (4) rear mounting holes for ¼ inch (6 mm) socket head cap screws, 3½ inches (90 mm) long (for a ¼ inch ***minimum*** mounting plate thickness). The instrument is supplied with four (4) ¼ inch – 28 x 3½ inch socket head cap screws for convenience.

Please allow 4-inch (100 mm) clearance under the instrument for installation of test line and for hand clearance.



Installation

The leak test instrument is a modular, flexible instrument designed to operate in a manufacturing, clean room, or lab environment. To operate trouble-free, review the Sentinel MH Technical Specifications before installing this instrument.

Because this is a precision instrument, it is preferable to locate this instrument at least 15 feet (5 meters) away from high electromagnetic energy devices (induction heat treat equipment and welders) whenever possible. In addition, plants having poor quality electrical power or ground systems should consider using isolation transformers on the power drops.

Note: When supplying power, always be certain that there is nearly zero voltage (< 1 V) difference between the DC common and earth ground wires connected to the instrument.

DC Power Connection

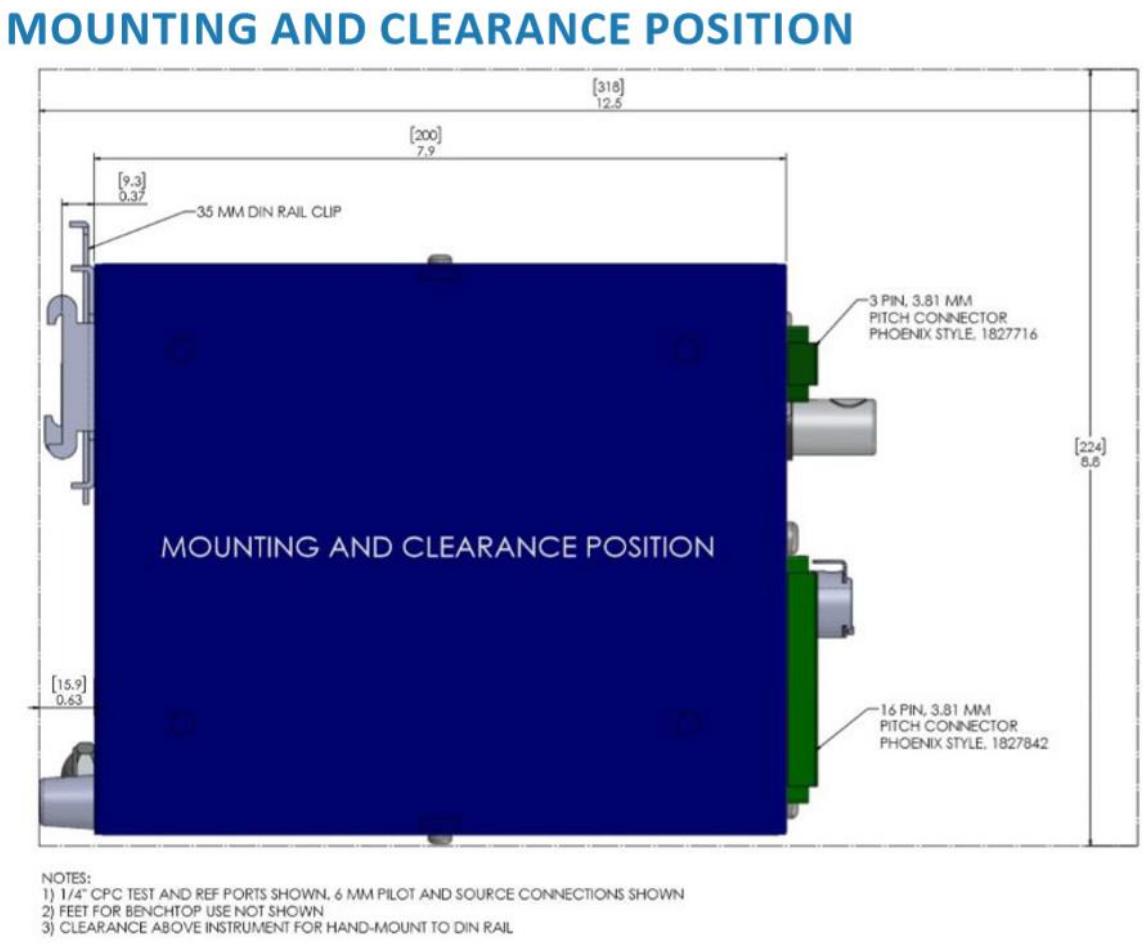
Supply Connections

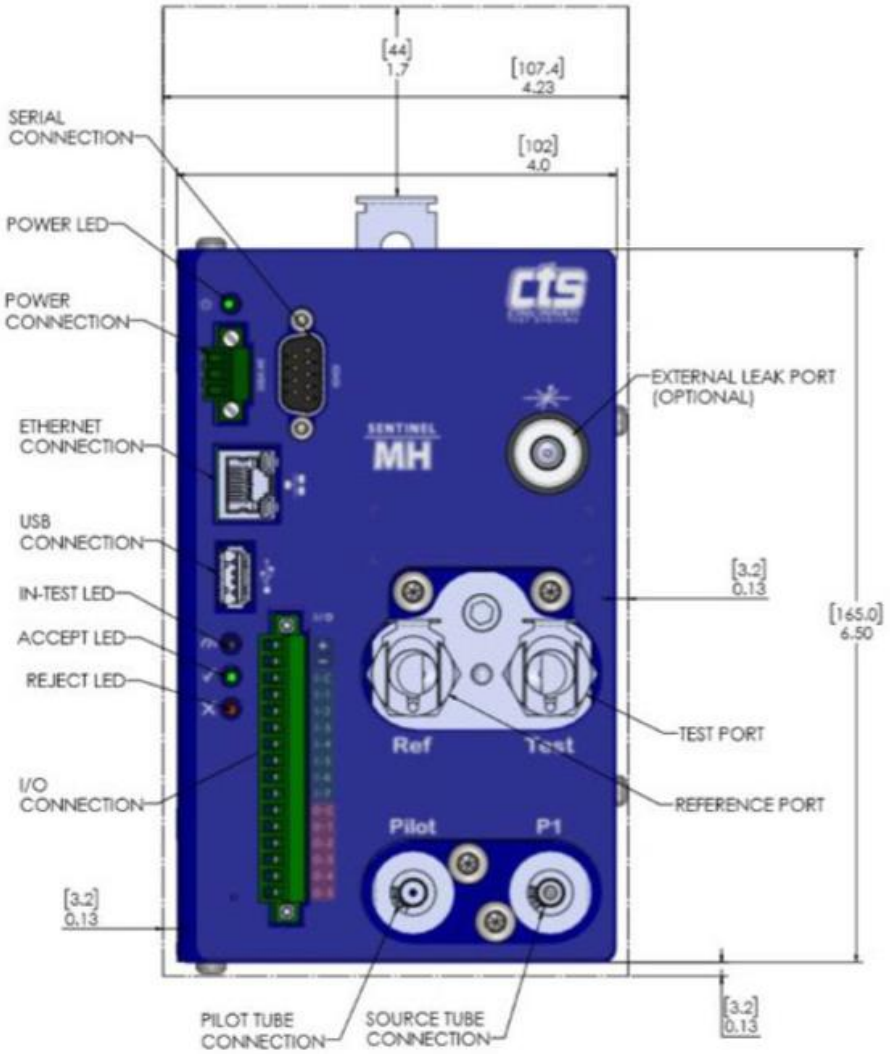
After mounting or locating the instrument, connect the inlet air or vacuum supply to the inlet port shown in the pneumatic diagram supplied with your specific instrument, as this will vary depending on instrument configuration. To reduce future maintenance requirements, install the recommended 0.3 and 5.0-micron coalescing filters in the air supply connected to the instrument. Be certain to replace the filter elements at least quarterly as preventive maintenance. ISO 8573-1, Class 2 filters are recommended, with class 3 being acceptable.

Port	Connection Type	Pressure Rating
Test Supply	1/4" Pushlock	Vacuum-0 OR 0-200 psi
Pilot	1/8" Pushlock	55-70 psi

MH Front view

Top View


MOUNTING AND CLEARANCE POSITION
[318]
12.5
[200]
7.9
[9.3]
0.37
35 MM DIN RAIL CLIP
3 PIN, 3.81 MM
PITCH CONNECTOR
PHOENIX STYLE, 1827716
[224]
8.8
MOUNTING AND CLEARANCE POSITION
[15.9]
0.63
16 PIN, 3.81 MM
PITCH CONNECTOR
PHOENIX STYLE, 1827842
NOTES:
1) 1/4" CPC TEST AND REF PORTS SHOWN. 6 MM PILOT AND SOURCE CONNECTIONS SHOWN
2) FEET FOR BENCHTOP USE NOT SHOWN
3) CLEARANCE ABOVE INSTRUMENT FOR HAND-MOUNT TO DIN RAIL


[44]
1.7
[107.4]
4.23
[102]
4.0
SERIAL CONNECTION
POWER LED
POWER CONNECTION
ETHERNET CONNECTION
USB CONNECTION
IN-TEST LED
ACCEPT LED
REJECT LED
I/O CONNECTION
[3.2]
0.13
EXTERNAL LEAK PORT (OPTIONAL)
SENTINEL
MH
[3.2]
0.13
[165.0]
6.50
Ref
Test
TEST PORT
REFERENCE PORT
Pilot
P1
[3.2]
0.13
PILOT TUBE CONNECTION
SOURCE TUBE CONNECTION
[3.2]
0.13

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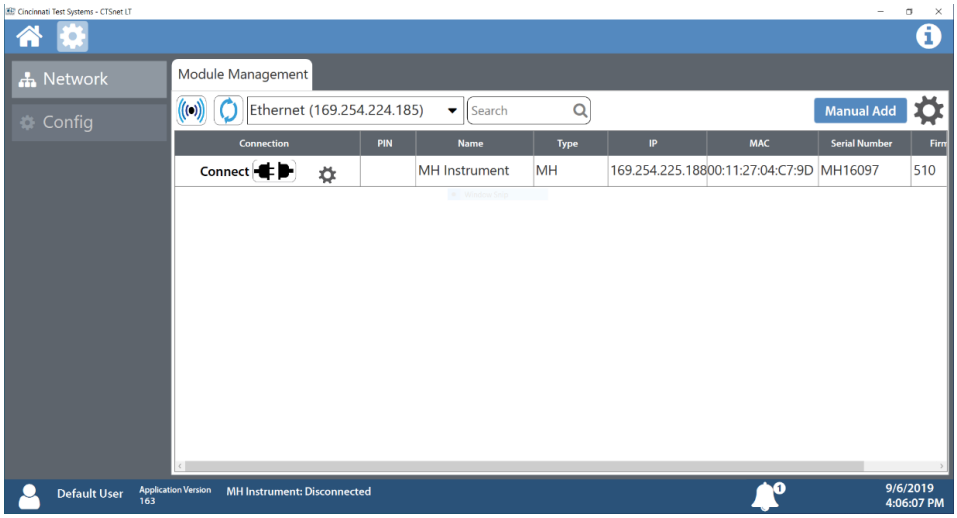
Chapter 2 – CTSnet LT

This chapter explores the basic use of CTSnet LT. CTSnet LT is a graphical user interface that allows you to control, configure and monitor your instrument, all from a single, easy-to-use application. Please refer to the quick start guide on the USB drive included with your instrument for instructions on installing the application.

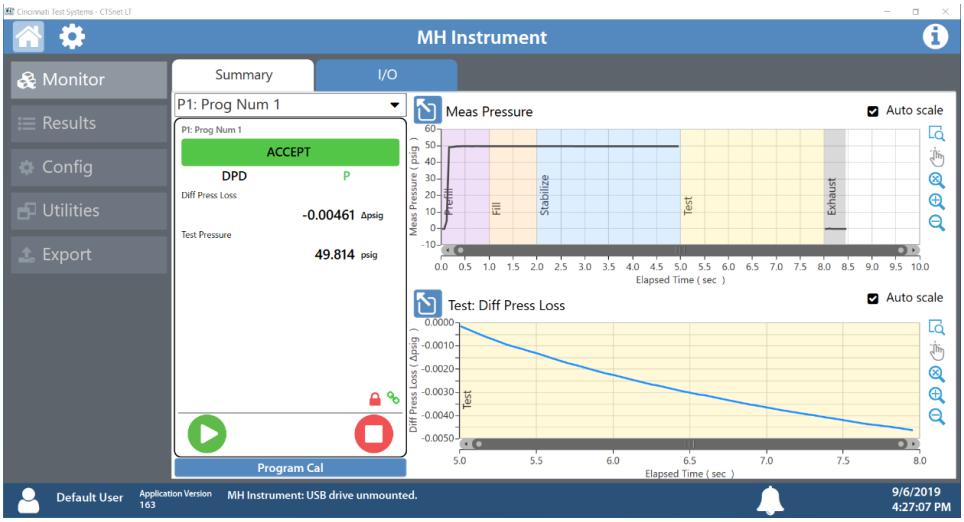
Initial Startup

After Setting up your MH instrument(s) on the network, launch CTSnet LT. Your instrument(s) will appear on the Module Management screen. You can connect to an MH by pressing the connect icon on each available instrument. The connected instrument's information will turn green to indicate that it is connected.



Note: The CTSnet LT application can only connect to one MH instrument at time.

Once an MH instrument is connected, you will be taken to the home menu. From here you can fully control and configure the MH to your specifications. This includes running and monitoring tests and calibration.



To get help on a menu item, press the info icon and select the item. To exit help mode, click the info icon again.

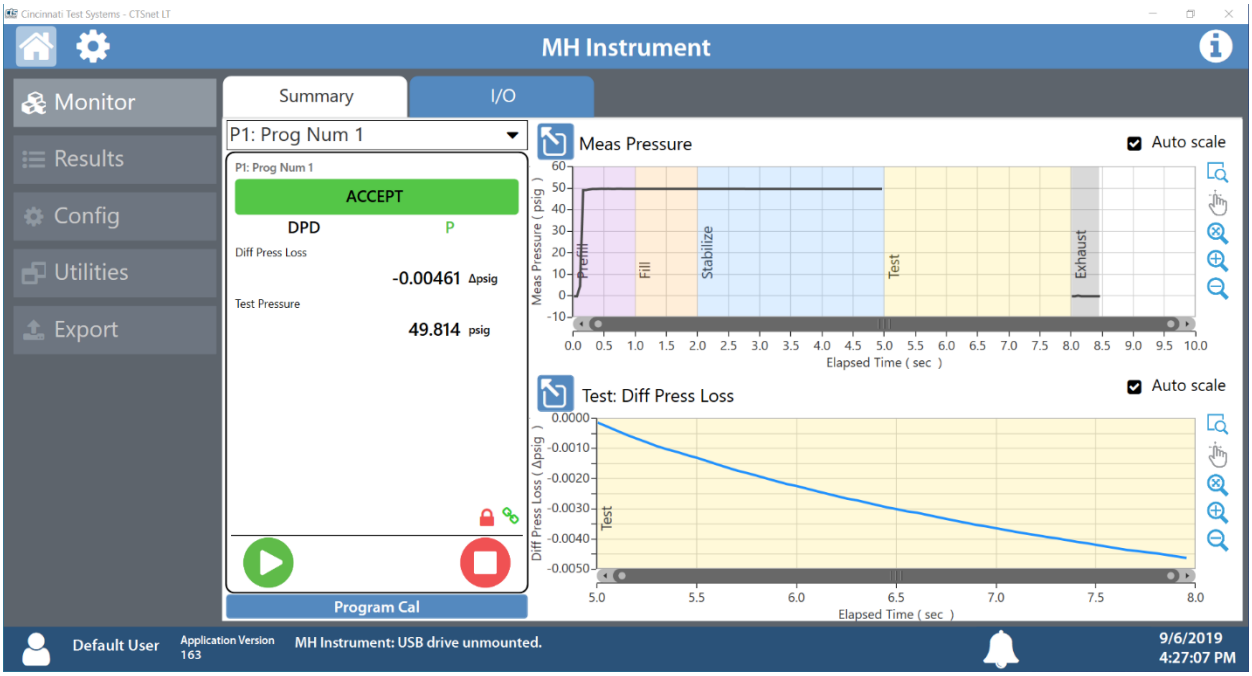
Monitor Screen

Summary Tab

The Summary tab will allow you to start, stop and hold tests. You can select the program being run by using the drop-down selector. Program calibration, if available for the selected program, can be performed from this tab as well.

The test can be visually monitored through its stages on the top plot. This plot displays the value of the primary transducer against elapsed time, as well as marking each phase of the test with color coordination. The bottom plot will display the value of the Secondary Transducer during the test phase.

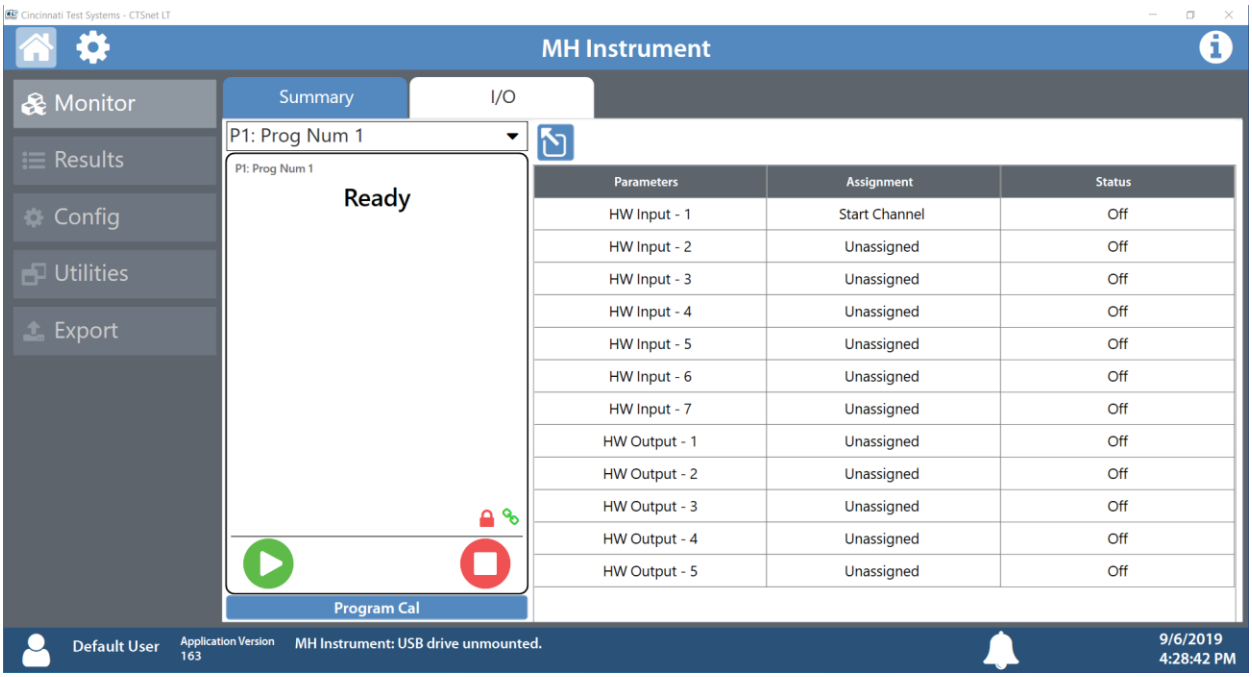
Each plot can be interacted with using the icons to the right of the plot or expanded to fit the screen with the maximize button in the upper left of the plot.



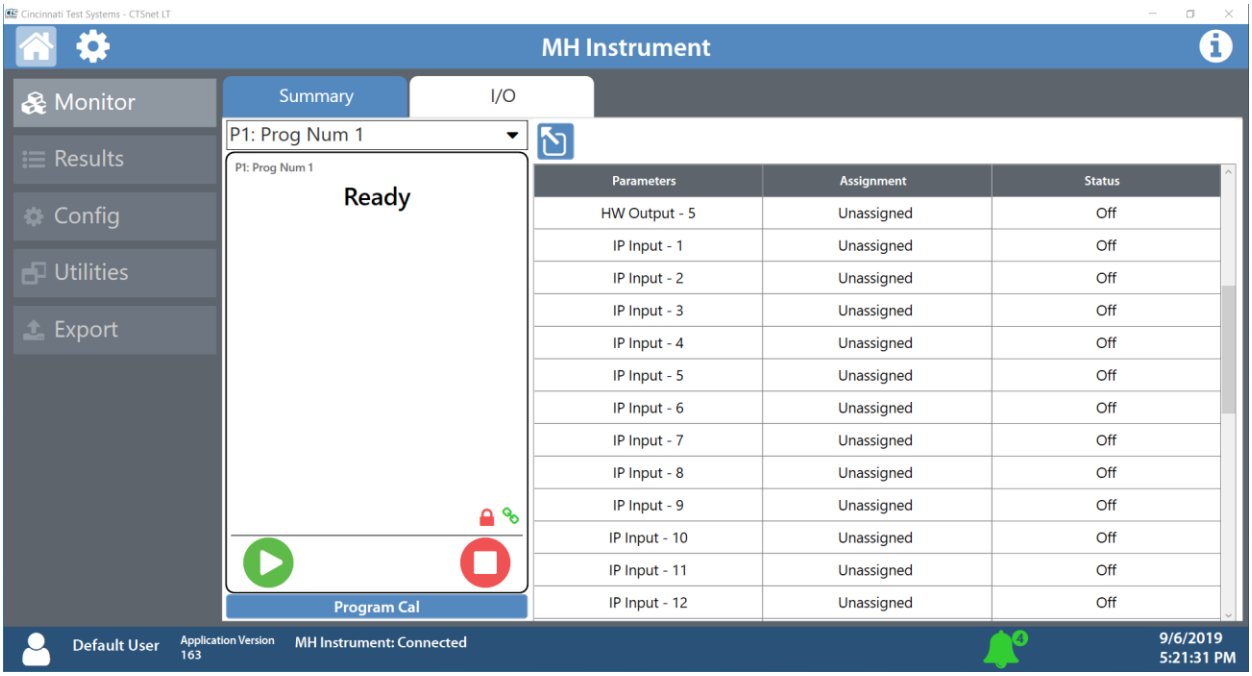
Plots shown are for demonstration, actual view may differ based upon the selected test type.

IO Tab

The I/O tab will allow you to monitor each input and output state in real time. This window can be expanded to fit the full screen by pressing the maximize button on the upper left of the I/O list.



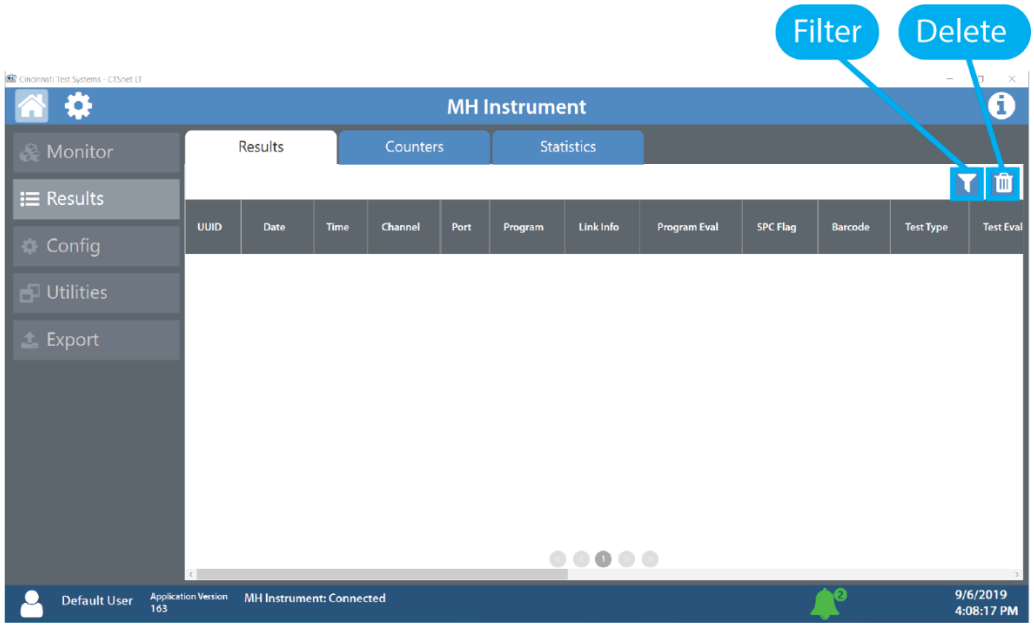
When Ethernet/IP is enabled, the Ethernet/IP IO states will also be displayed here.



Results Screen

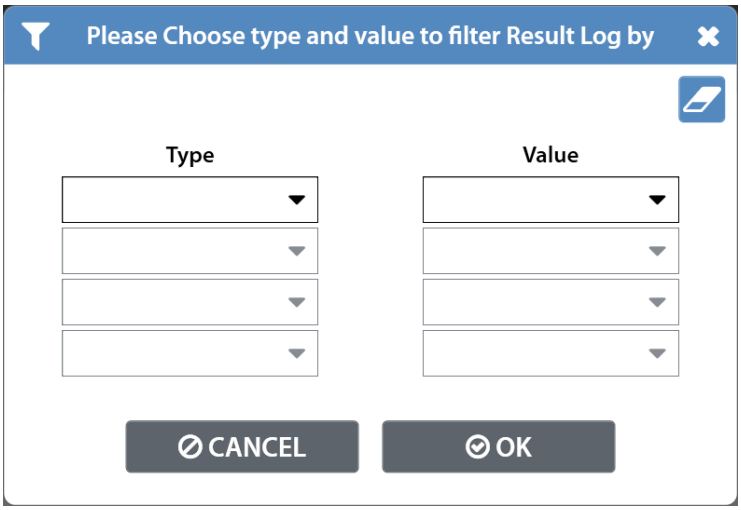
Results Tab

The Results tab displays the allowed number of results and allows for filtering by pressing the filter button. Results can also be cleared by pressing the delete button.



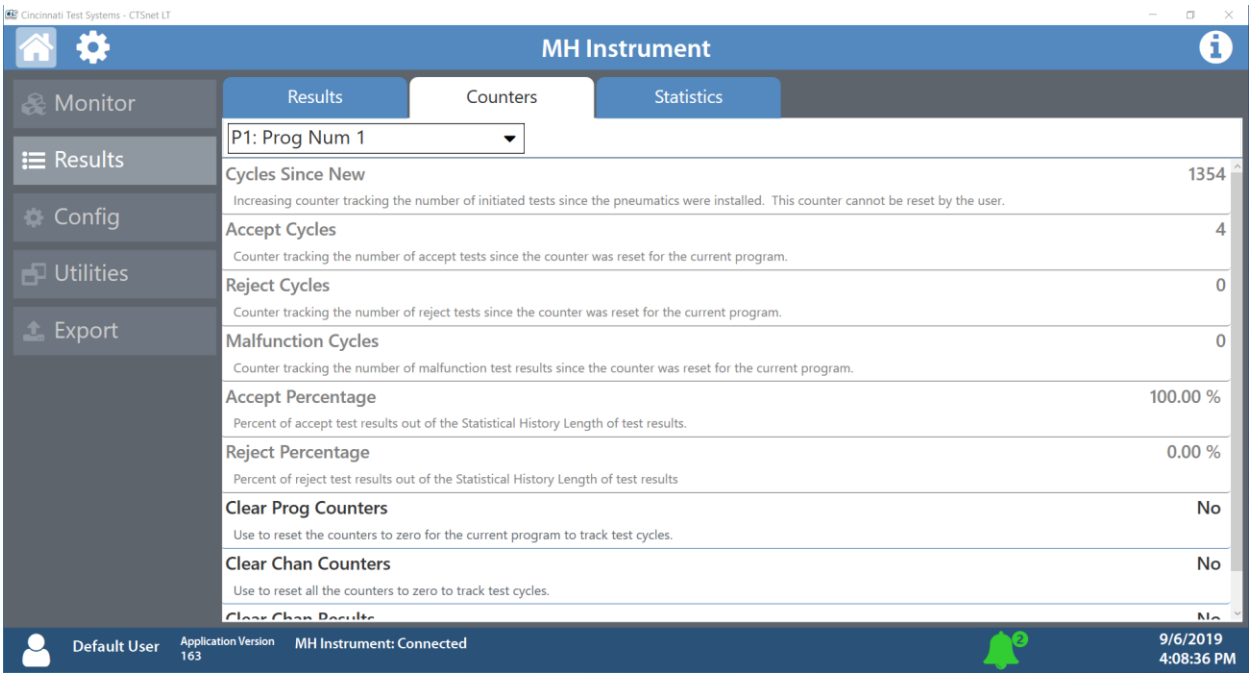
Filtering Results

You can create up to 4 filters to sort Result logs.



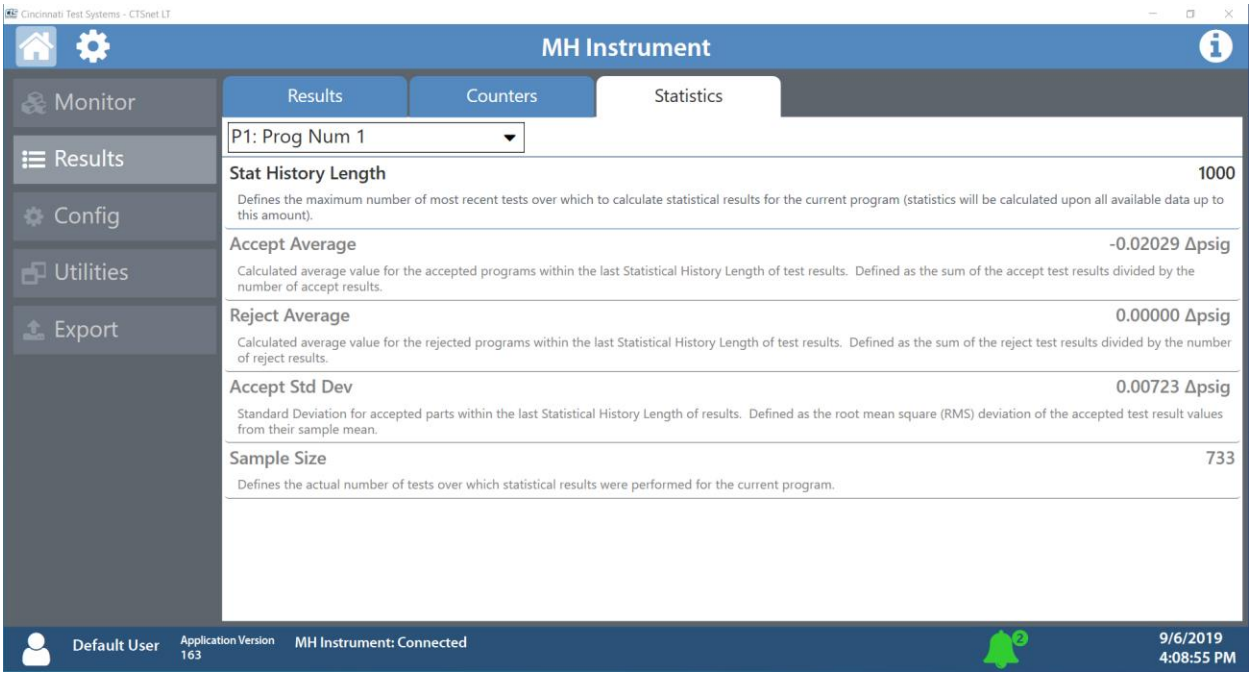
Counters Tab

The Counters tab displays the number of cycles performed on the instrument including the number of accept and reject cycles. These can be cleared to reset statistics.



Statistics Tab

The Statistics tab displays statistical analysis on the results from a selected program. The population of data can be adjusted using the Stat History Length parameter.

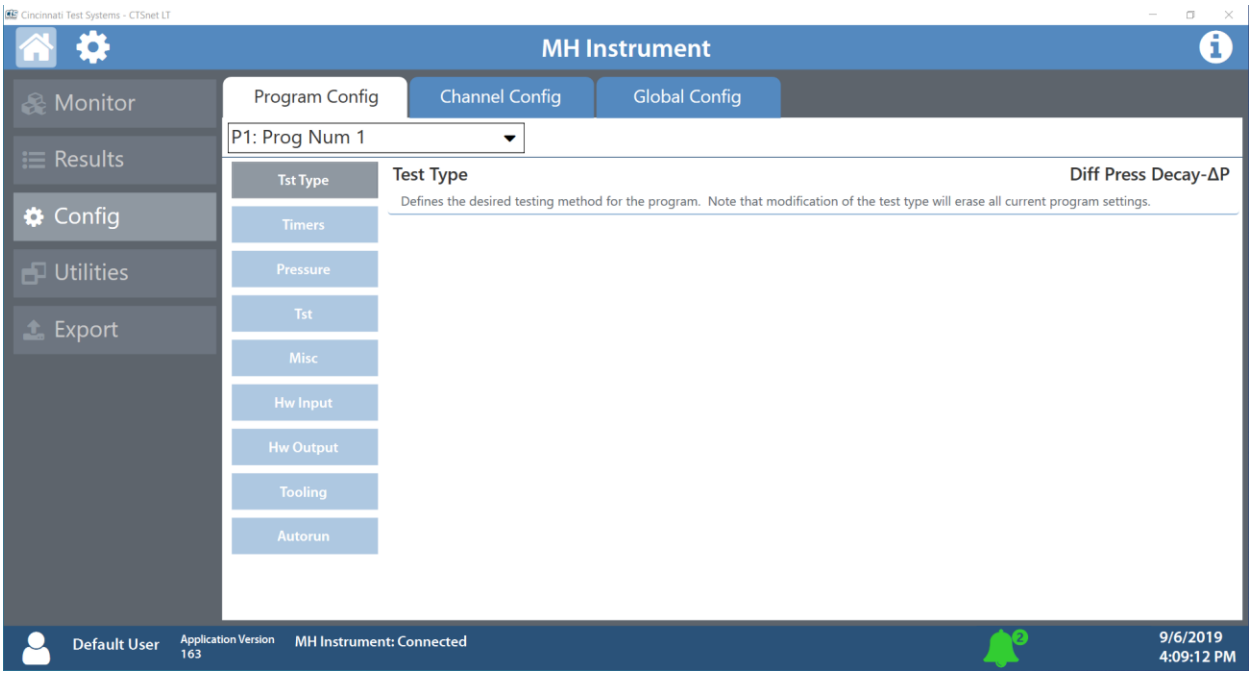


Configuration Screen

Program Configuration Tab

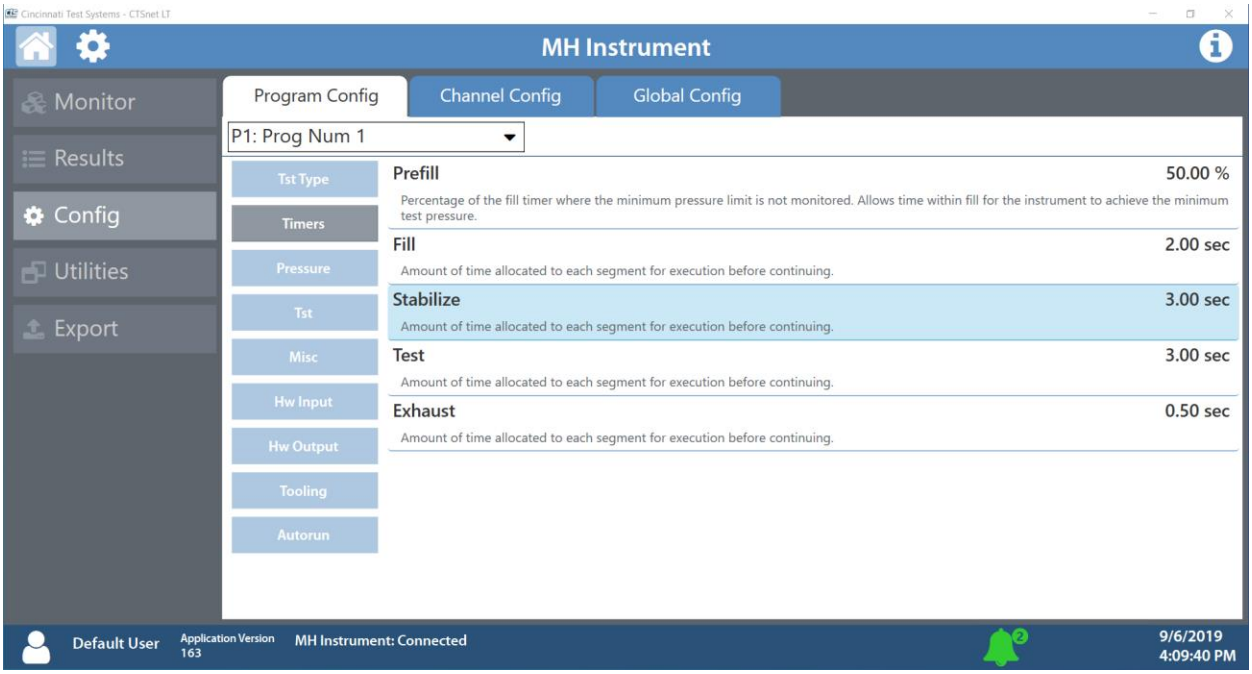
Selecting Test Types

The test type for the current program can be selected under the Tst Type menu. Refer to Chapter 3 – Setup for options. The drop-down menu at the top of the Program Config tab allows for configuration of up to 32 programs.



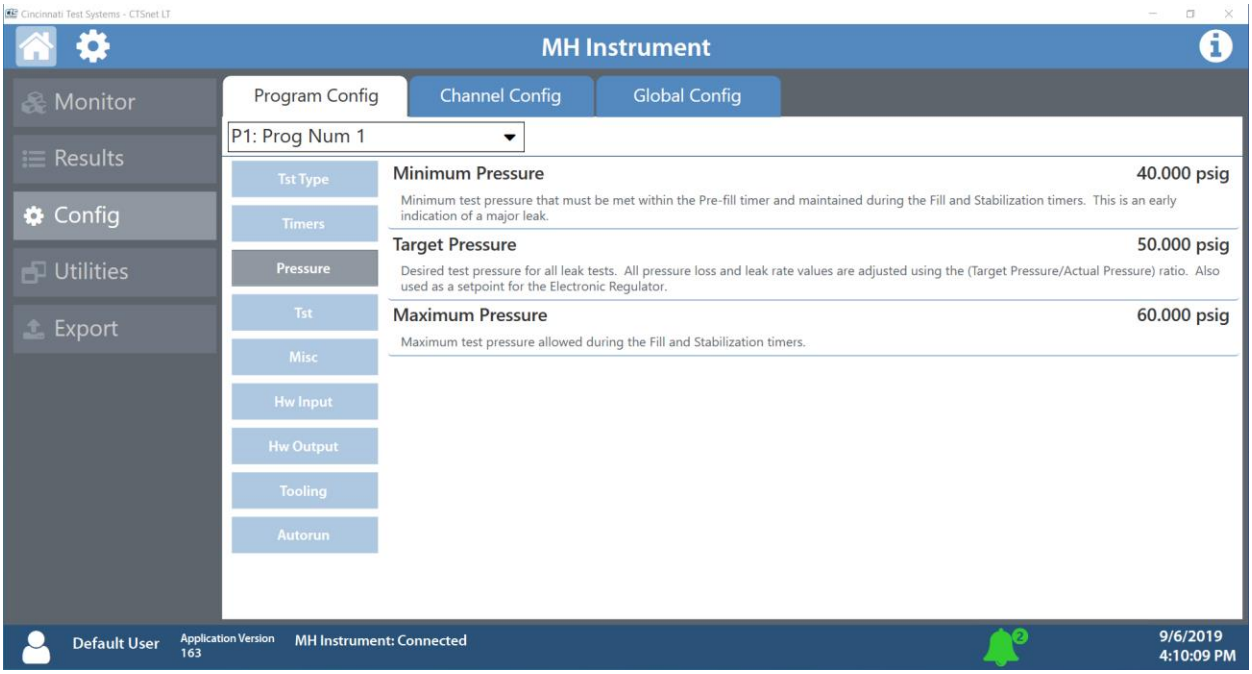
Setting Timers

Navigating to the Timers menu under the Program Config tab will allow you to set the various stage timers to the desired values. These timers may be preset at CTS for a specific set of test parameters. Please contact CTS to get information on how to set timers for your specific test. Timers are set per program and may vary depending on the selected test type.



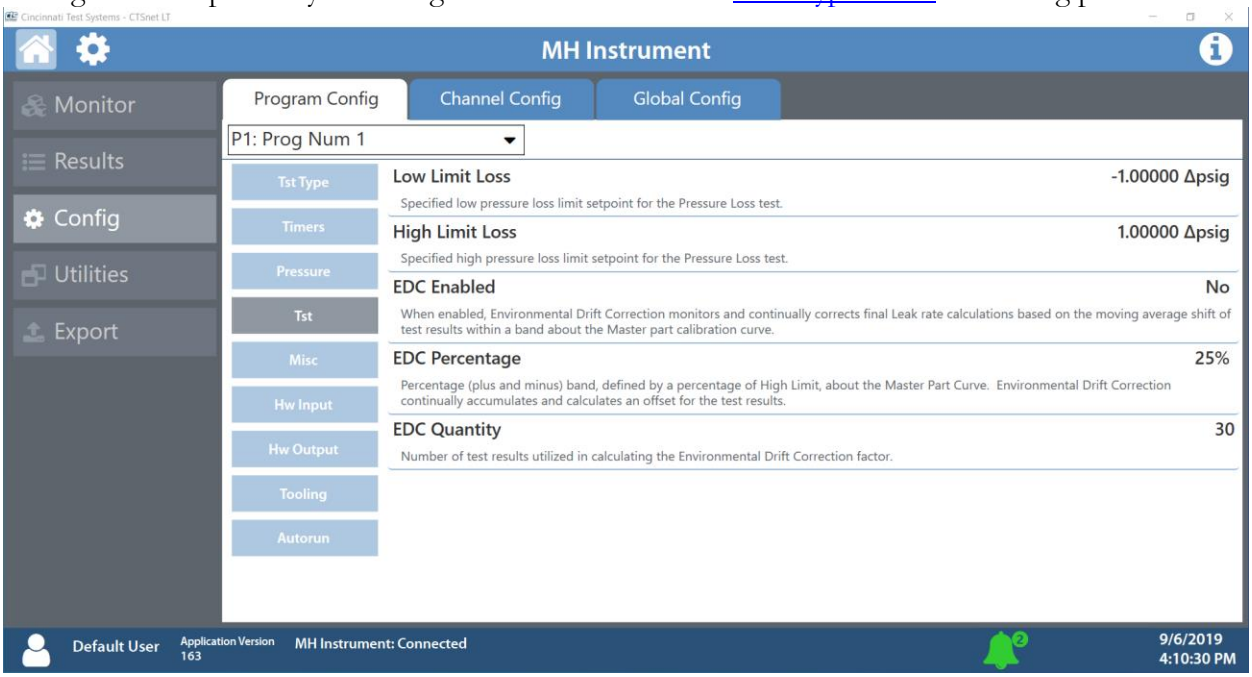
Setting Pressure

Navigating to the Pressure menu under the Program Config tab will allow you to set the target pressure for the selected test, as well as the minimum and maximum constraints for the test to continue.



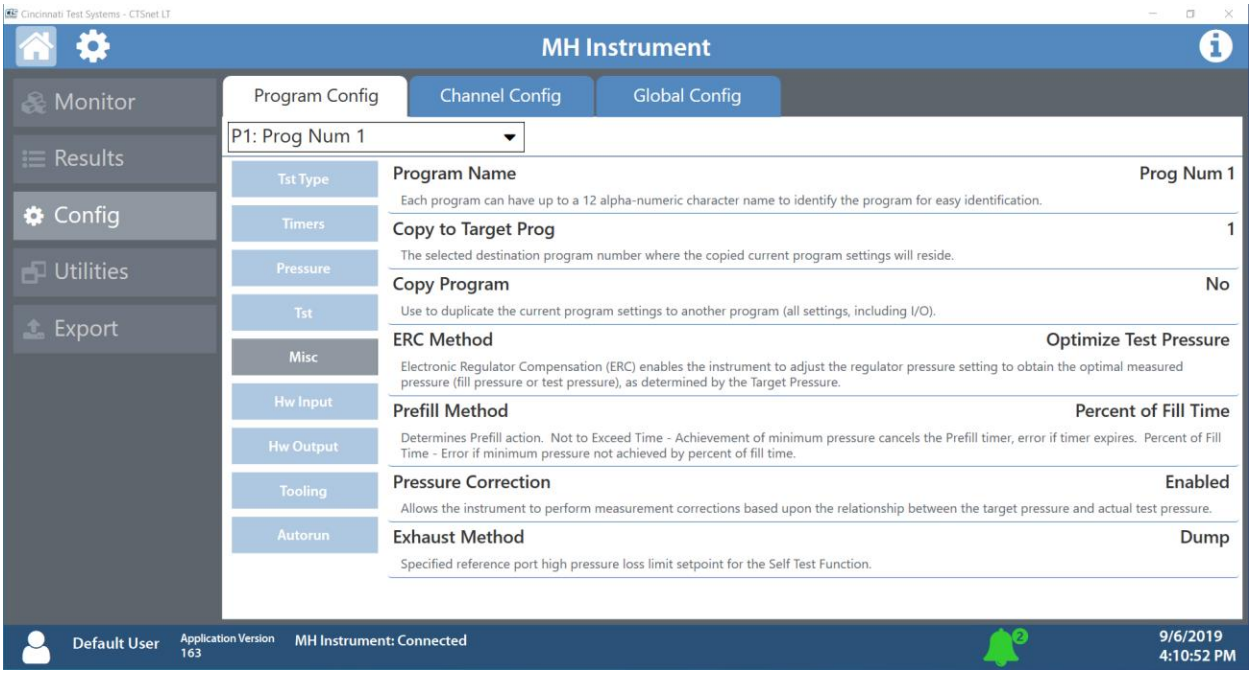
Setting Test Parameters

Navigating to the Tst menu under the Program Config tab will allow you to set the constraints of your test. For example: for a differential pressure decay test, the maximum pressure loss or gain through the test port may be configured here. Refer to the Test Type Table for setting parameters.



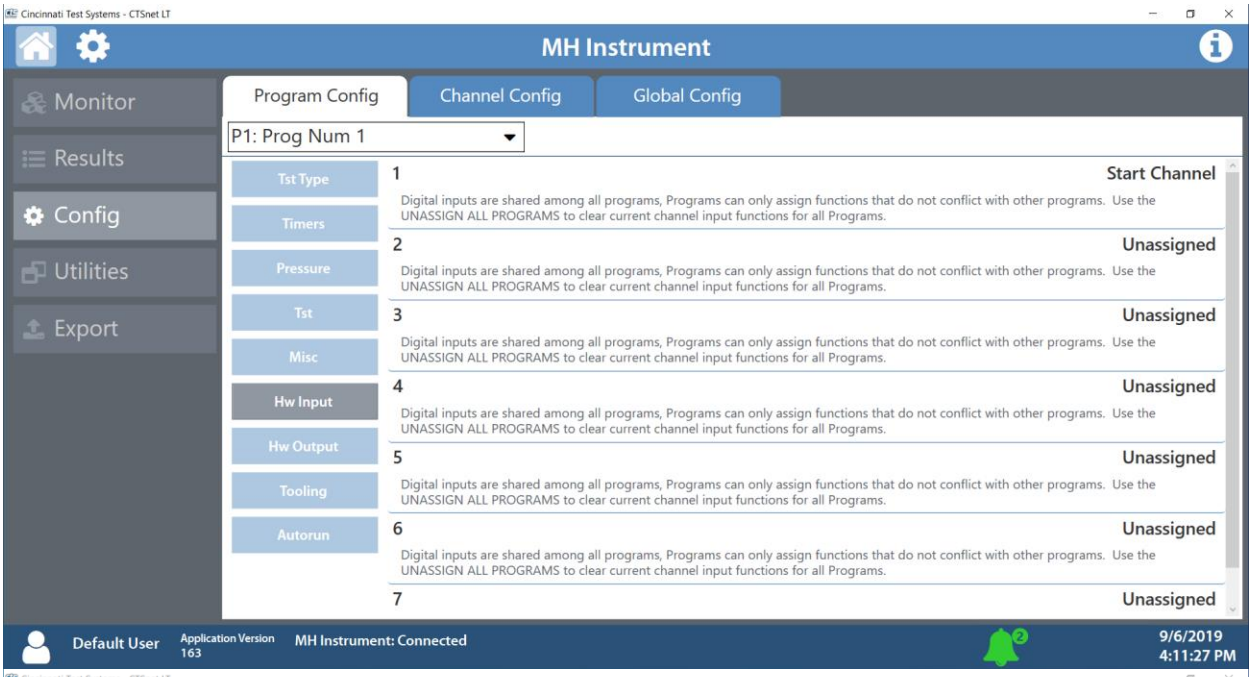
Miscellaneous settings

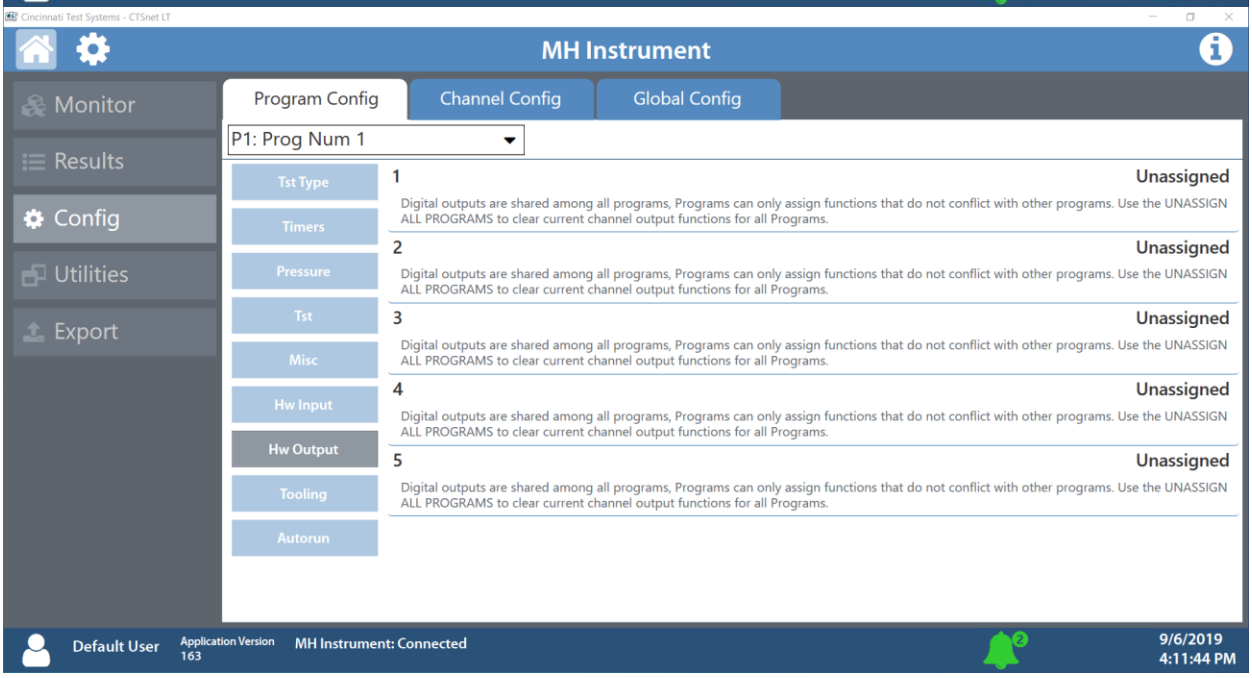
Navigating to the Misc menu under the Program Config tab will allow you to enter in a custom name for the selected program, as well as copy programs from one program to another. Various other settings, such as Electronic Regulator Control Method (if an electronic regulator is available), Prefill Method, Pressure Correction and Exhaust Method. Refer to Chapter 15 for setting parameters.



Hardware Input and Output

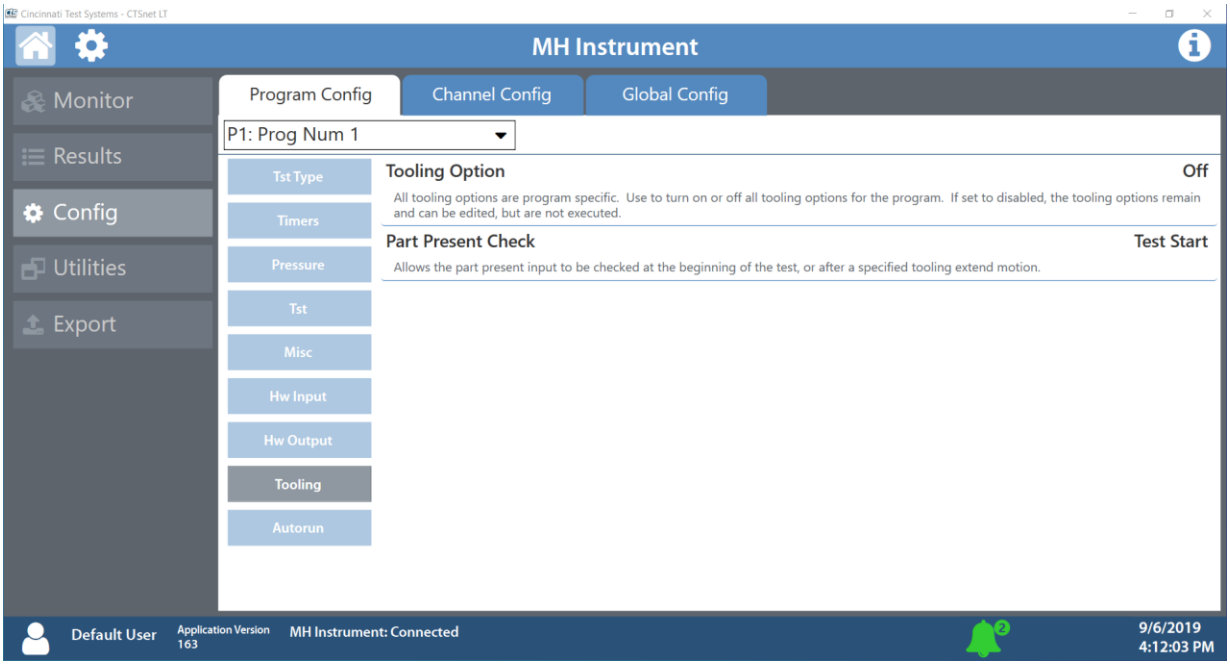
Navigating to the HW Input / Output menu under the Program Config tab will allow you to configure up to 7 inputs and 5 outputs. Refer to Chapter 10 – Inputs and Outputs for setting parameters.





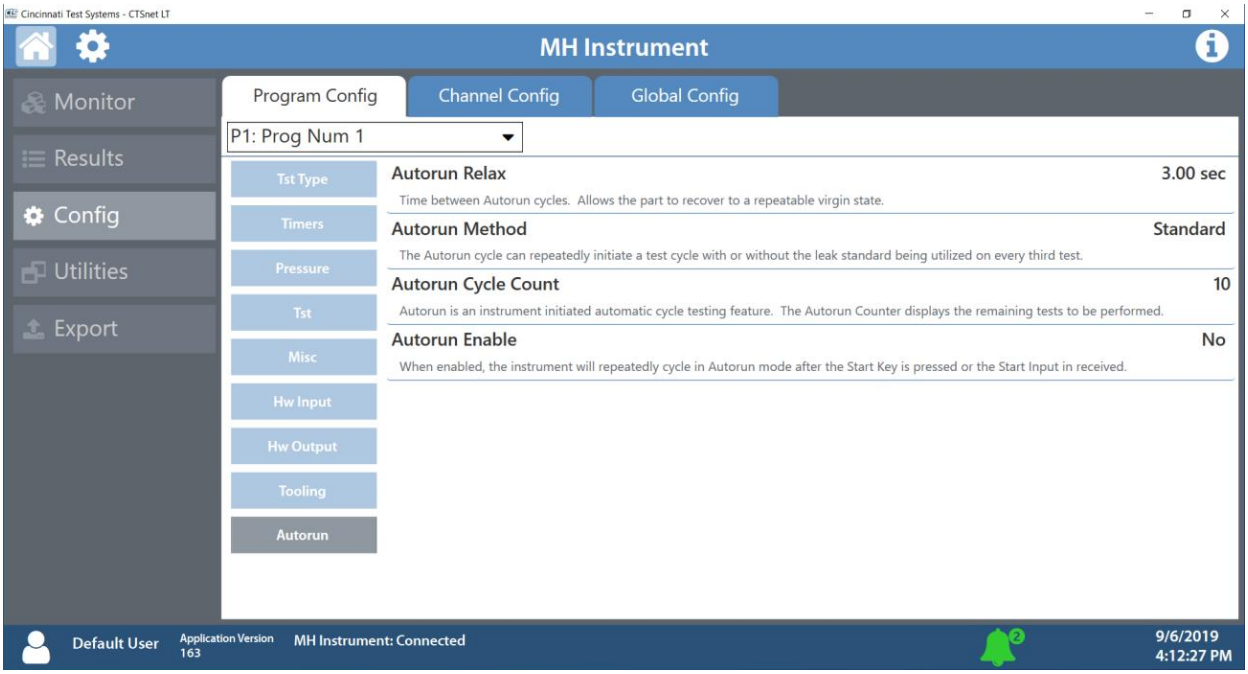
Tooling

Navigating to the Tooling menu under the Program Config tab will allow you to enable or disable tooling motions. The part present check input may be executed before or after tooling motions. Refer to Chapter 9 – Tooling Control



Autorun

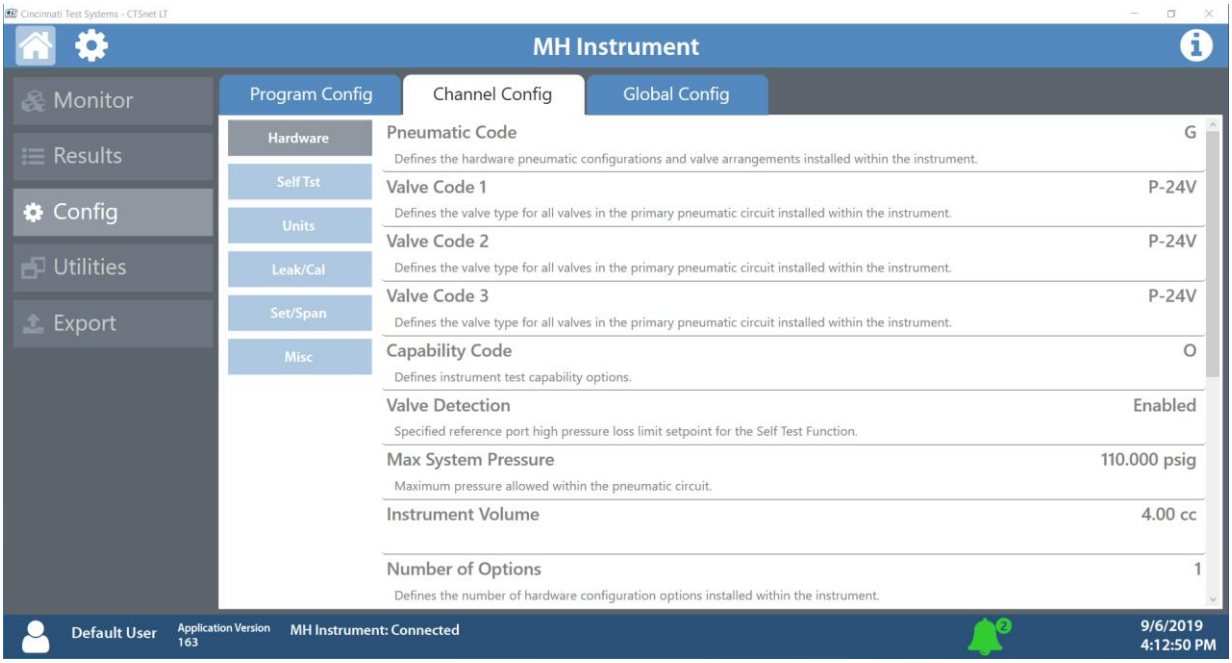
Navigating to the Autorun menu under the Program Config tab will allow you to configure automatic tests, where the selected program will be run a selected number of times. Refer to Chapter 15 - Autorun for setting parameters.



Channel Configuration Tab

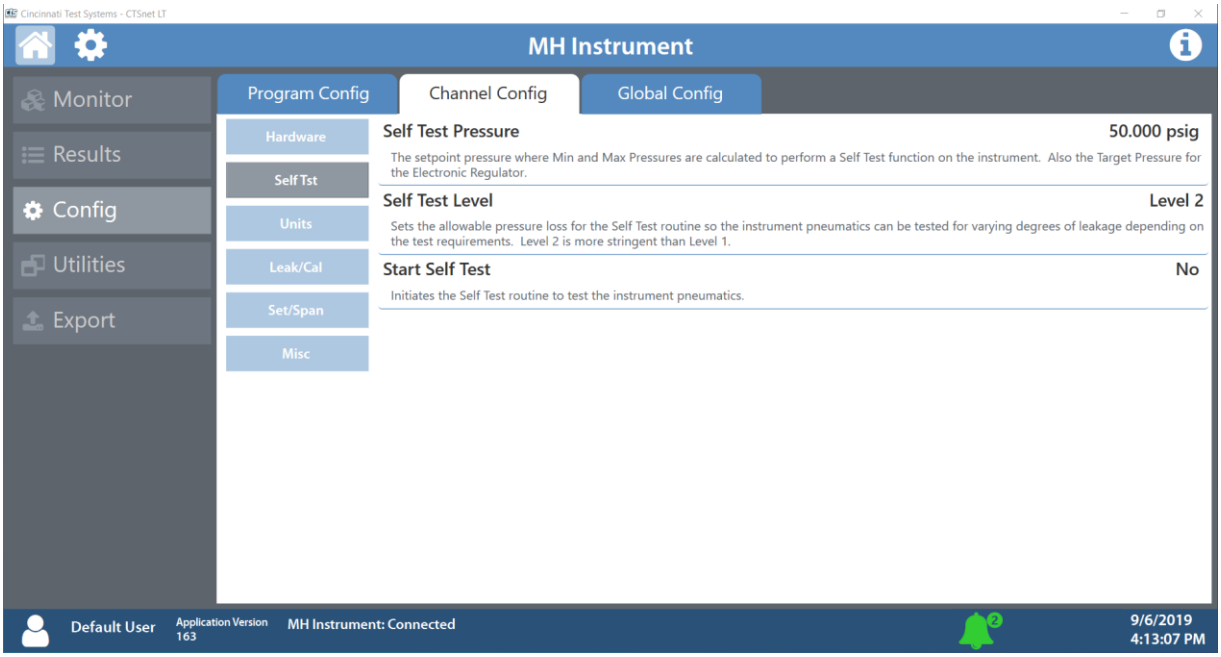
Hardware Configuration

Navigating to the Hardware menu under the Channel Config tab will allow you to view the factory settings of your MH instrument(s).



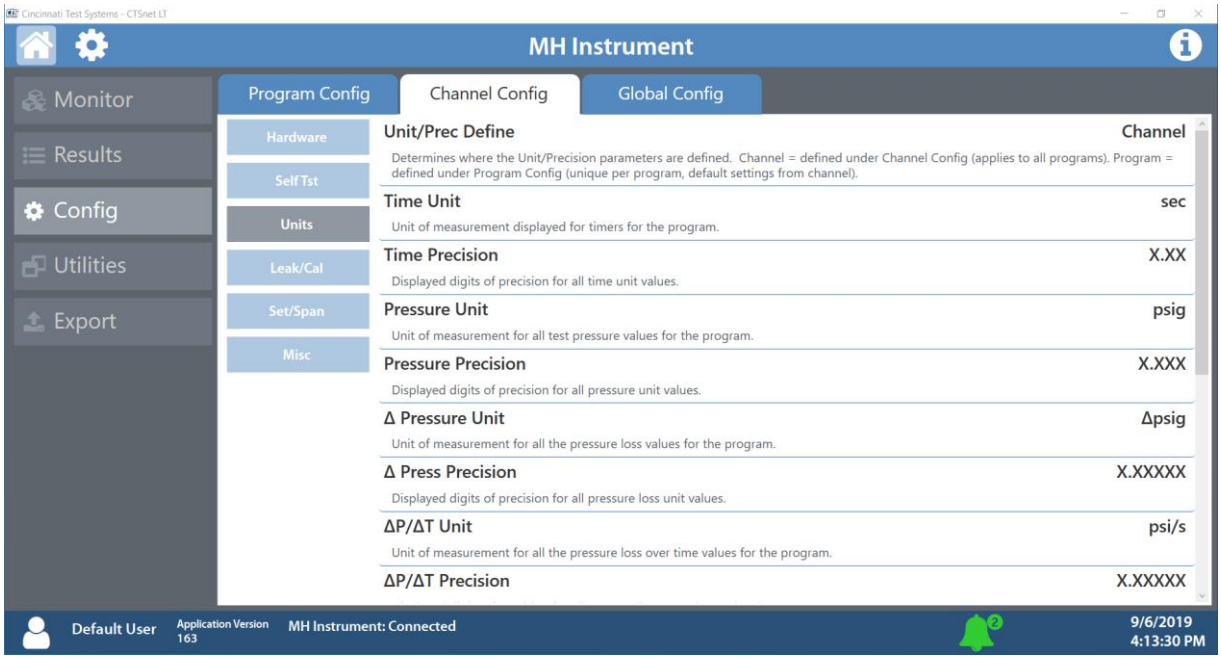
Self-Test

Navigating to the Self Tst menu under the Channel Config tab will allow you to check your MH instrument(s) for internal leaks at a set pressure. Refer to Chapter 15 - Self-Test for more information.



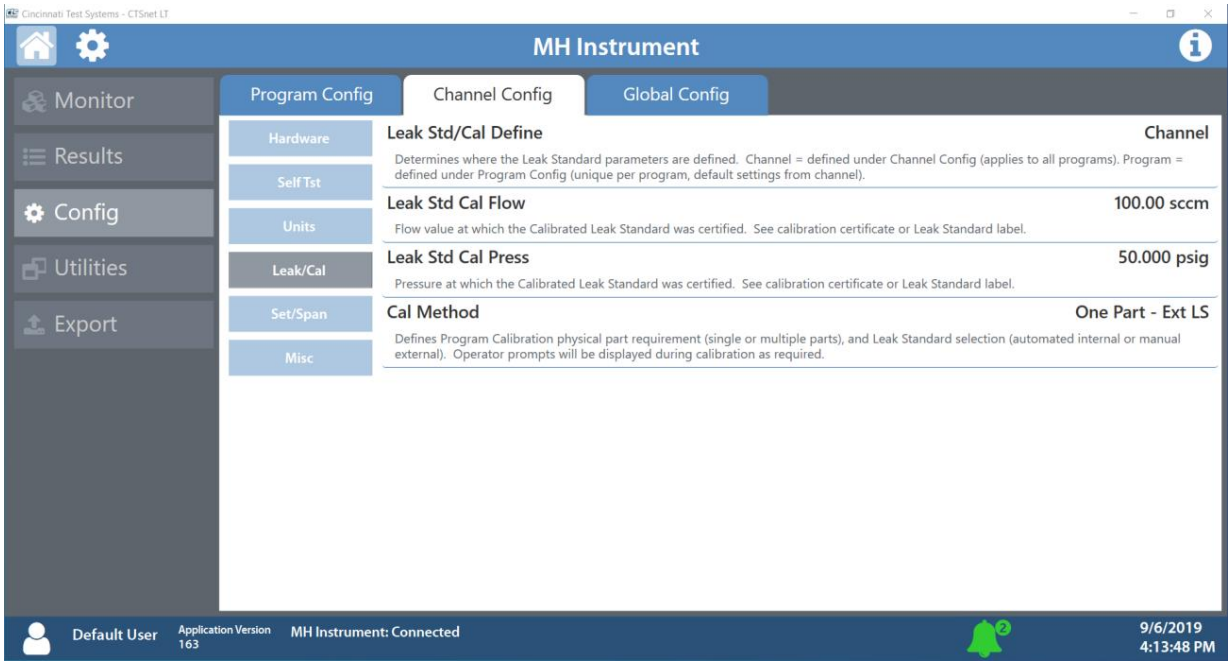
Setting Units

Navigating to the Units menu under the Channel Config tab will allow you to define units for every program. Refer to Chapter 3 - Setting the Units of Measure for more information and for setting parameters.



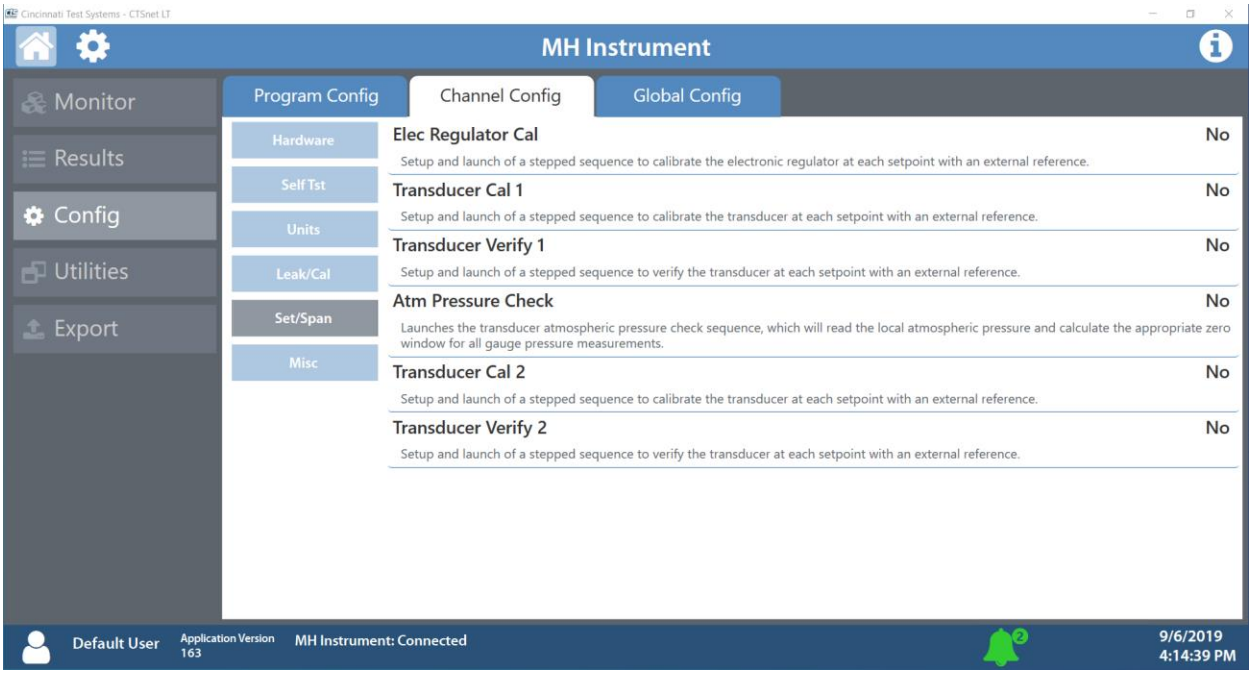
Leak and Calibration

Navigating to the Leak/Cal menu under the Channel Config tab will allow you to set the leak standard parameters for the MH instrument(s). Refer to Chapter 3 - Setting the Leak Standard Values for more information and for setting parameters.



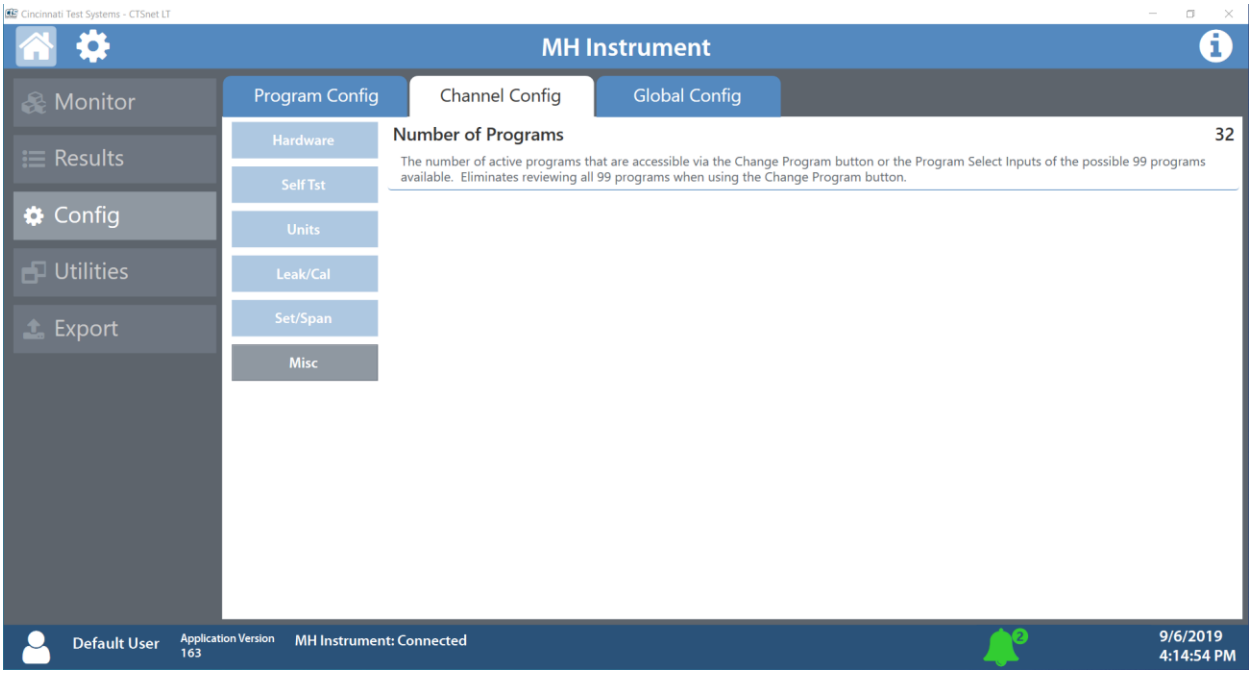
Calibration

Navigating to the Set/Span menu under the Channel Config tab will allow you to run verifications on the transducers available in the MH instrument as well as an Atmospheric Pressure Check to determine the current atmospheric pressure. Calibrations are done by CTS service. Refer to Chapter 3 - Setup for more information.



Miscellaneous parameters

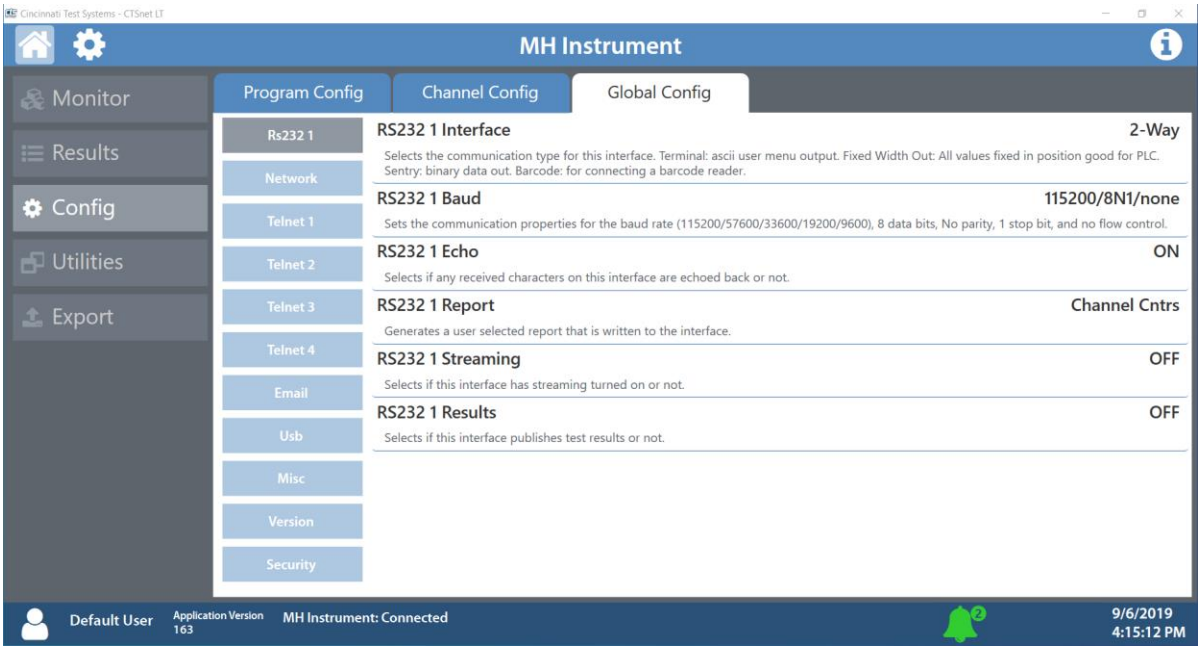
Navigating to the Misc menu under the Channel Config tab will allow you to set the maximum allowable programs available up to 32 total.



Global Configuration Tab

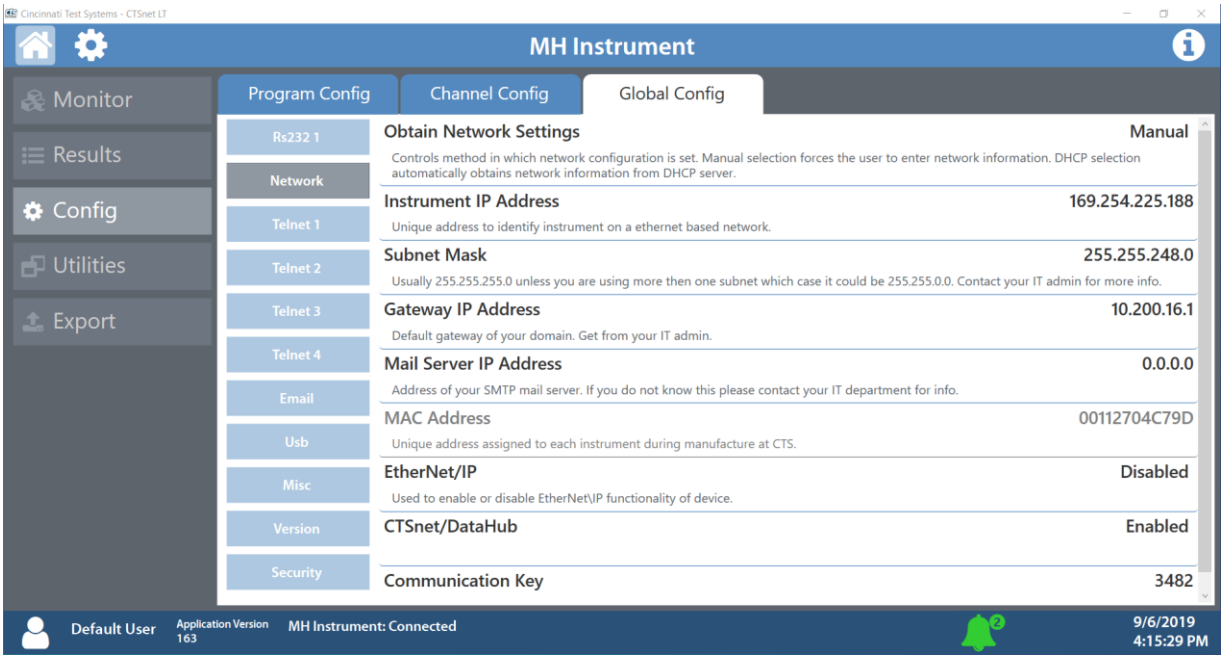
RS232

The instrument can perform direct serial communication. Refer to Chapter 12 – Communication for more information and setting parameters.



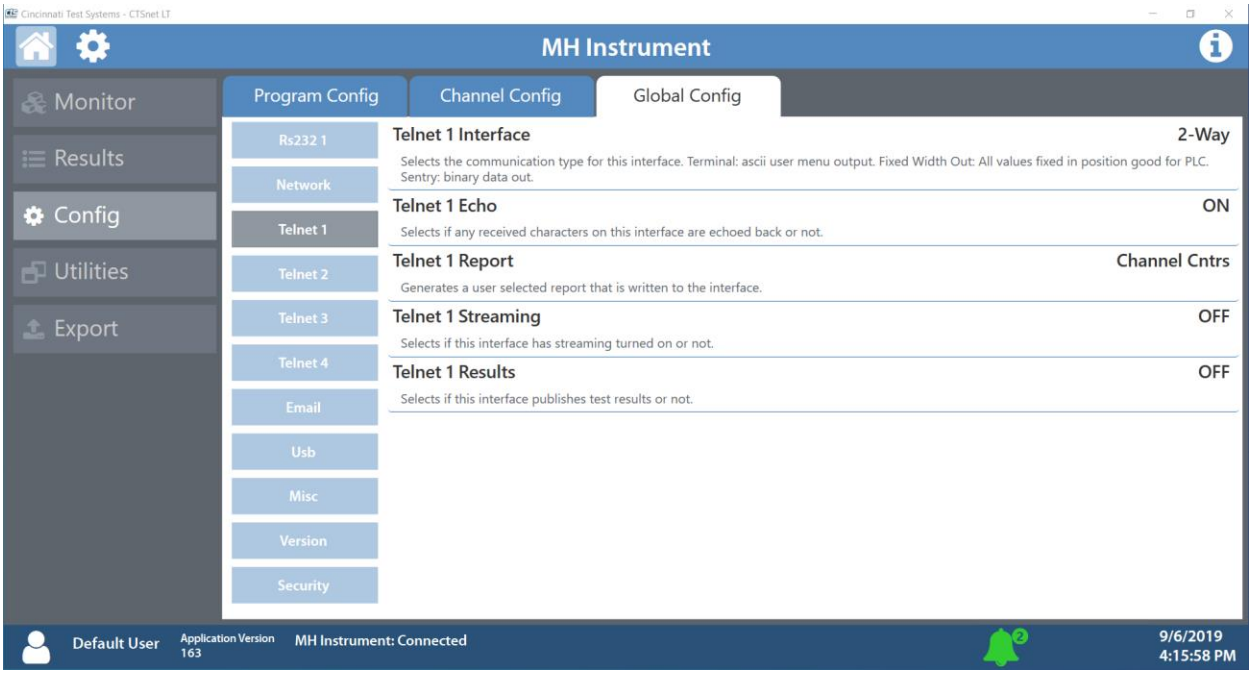
Network

Navigating to the Network menu under the Global Config tab will allow you to change the network parameters for your MH instrument(s). Please contact your IT department for valid network settings before making changes and refer to Chapter 12 – Communication for more information.



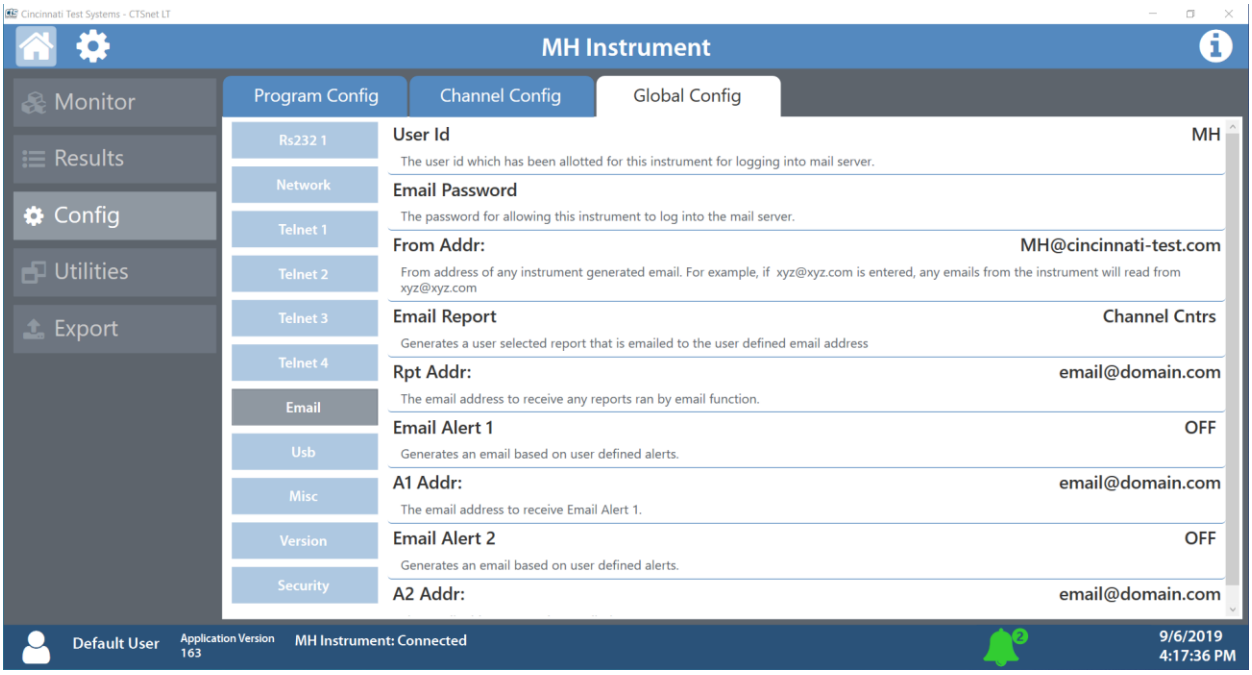
Telnet Communications

Navigating to the Telnet menus under the Global Config tab will allow you set various parameters regarding telnet communications. The MH instrument can support 4 separate telnet channels at once: Telnet 1, 2, 3 and 4. Refer to Chapter 12 - Communication for more information.



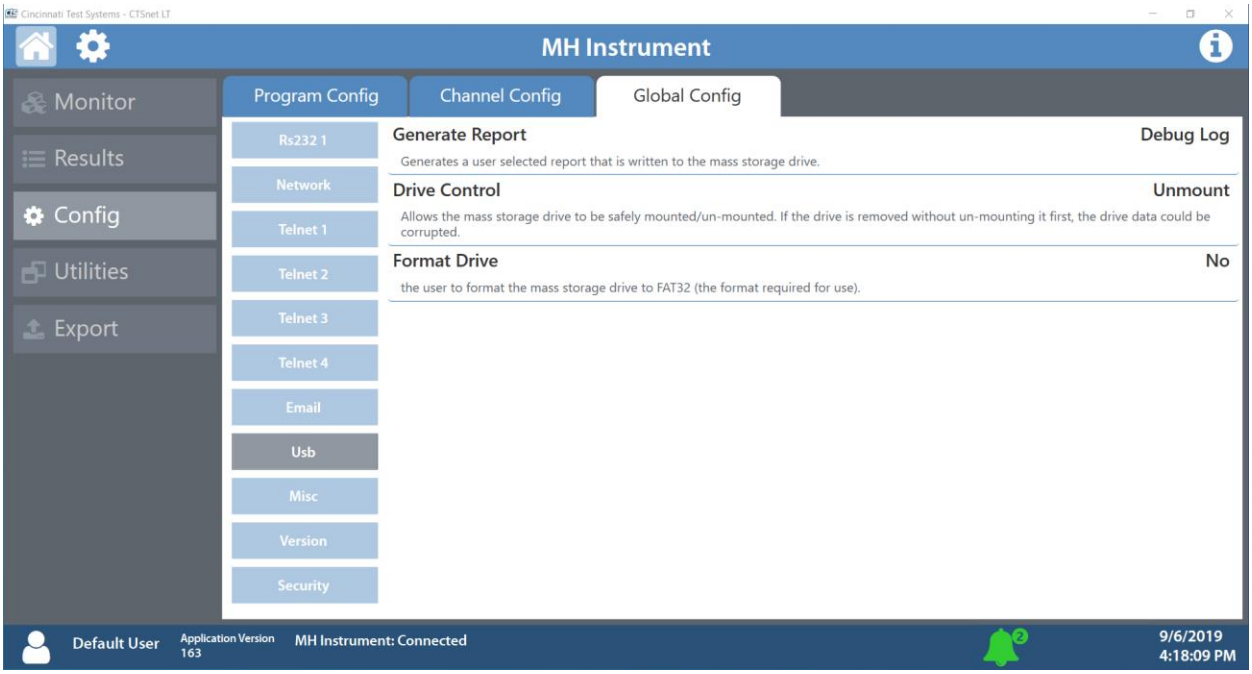
Email Settings

Navigating to the Hardware menu under the Global Config tab will allow you to create various email reports. Refer to Chapter 12 – Communication for more information.



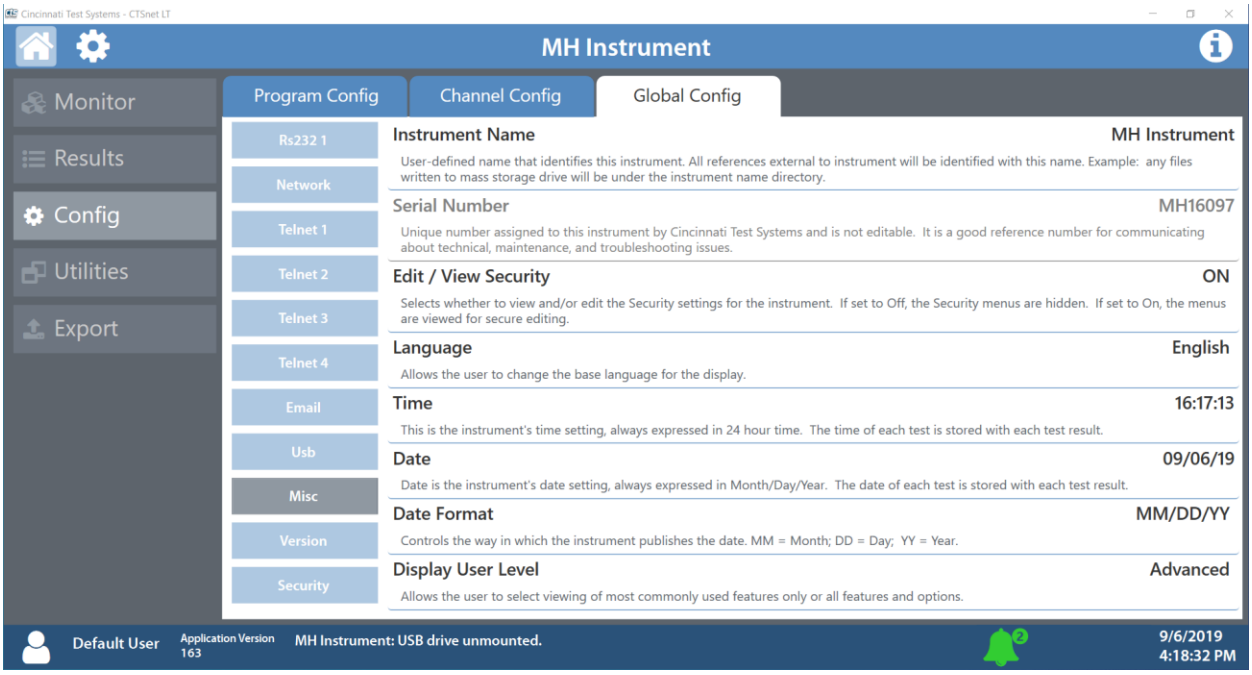
USB settings

Navigating to the USB menu under the Global Config tab will allow you to generate reports onto the USB device by directly connecting the USB device to the instrument.



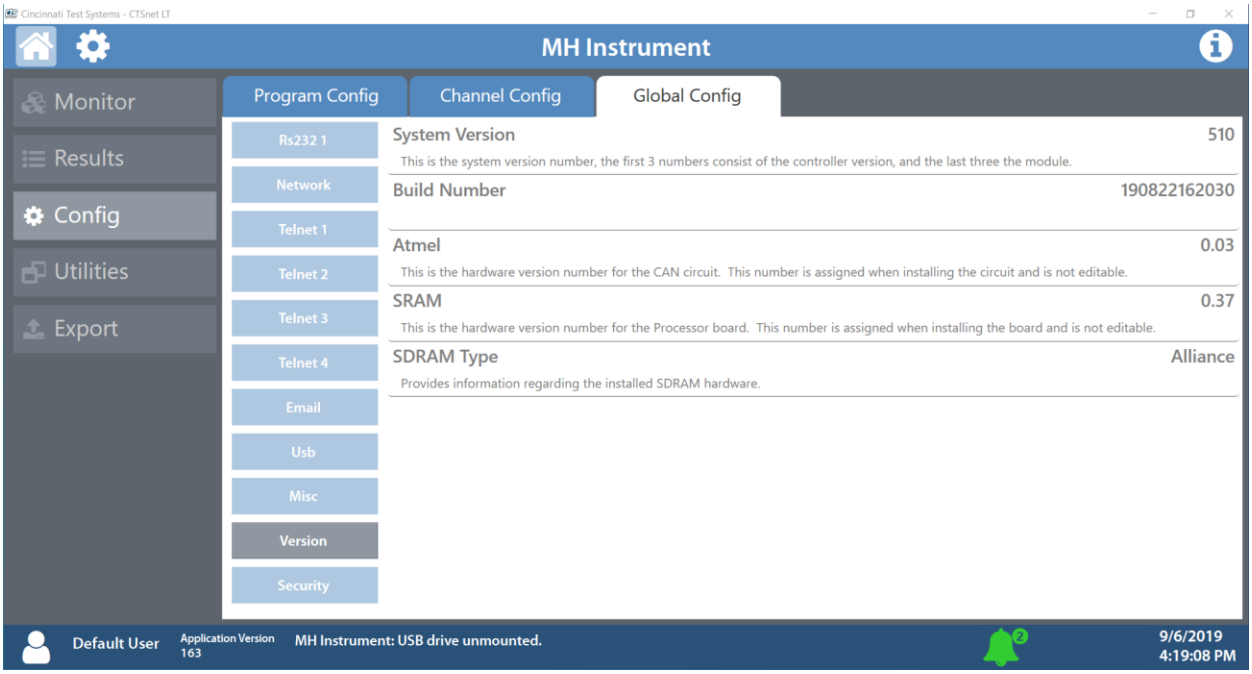
Miscellaneous settings

Navigating to the Misc menu under the Global Config tab will allow you to change your MH instrument's display name, date, time and user level. Refer to Chapter 15 – Features for more information and to set parameters.



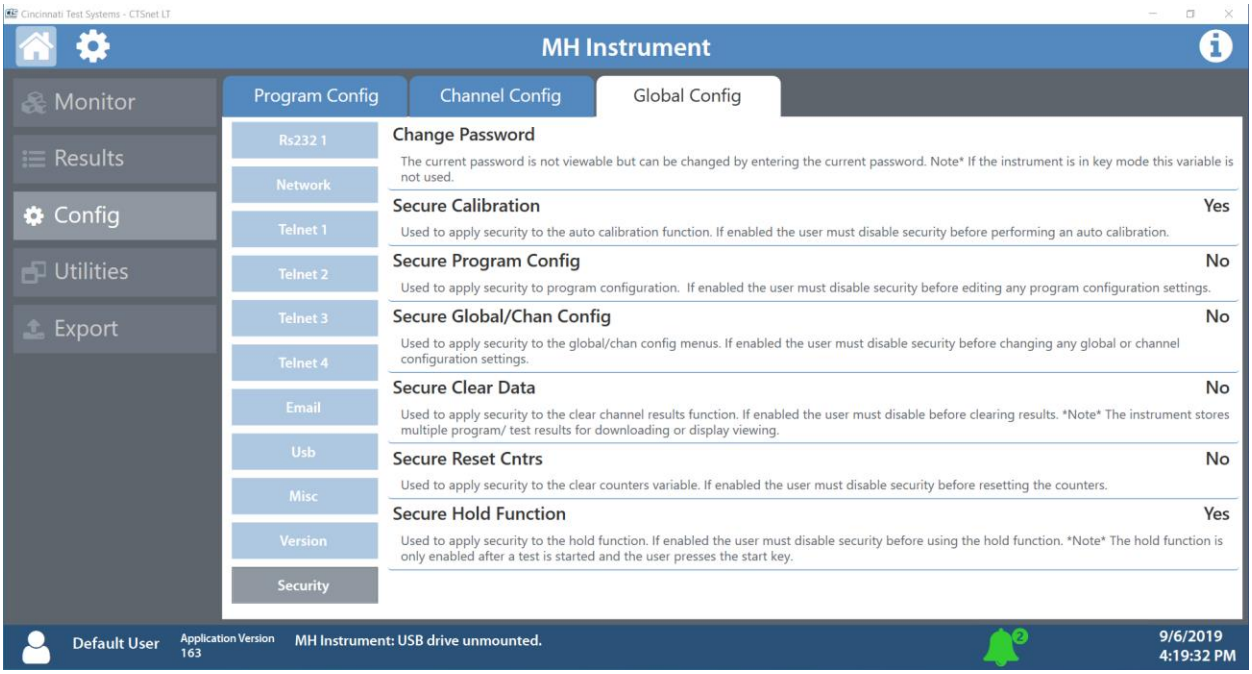
Version

Navigating to the Version menu under the Global Config tab will allow will display version information about your MH instrument(s).

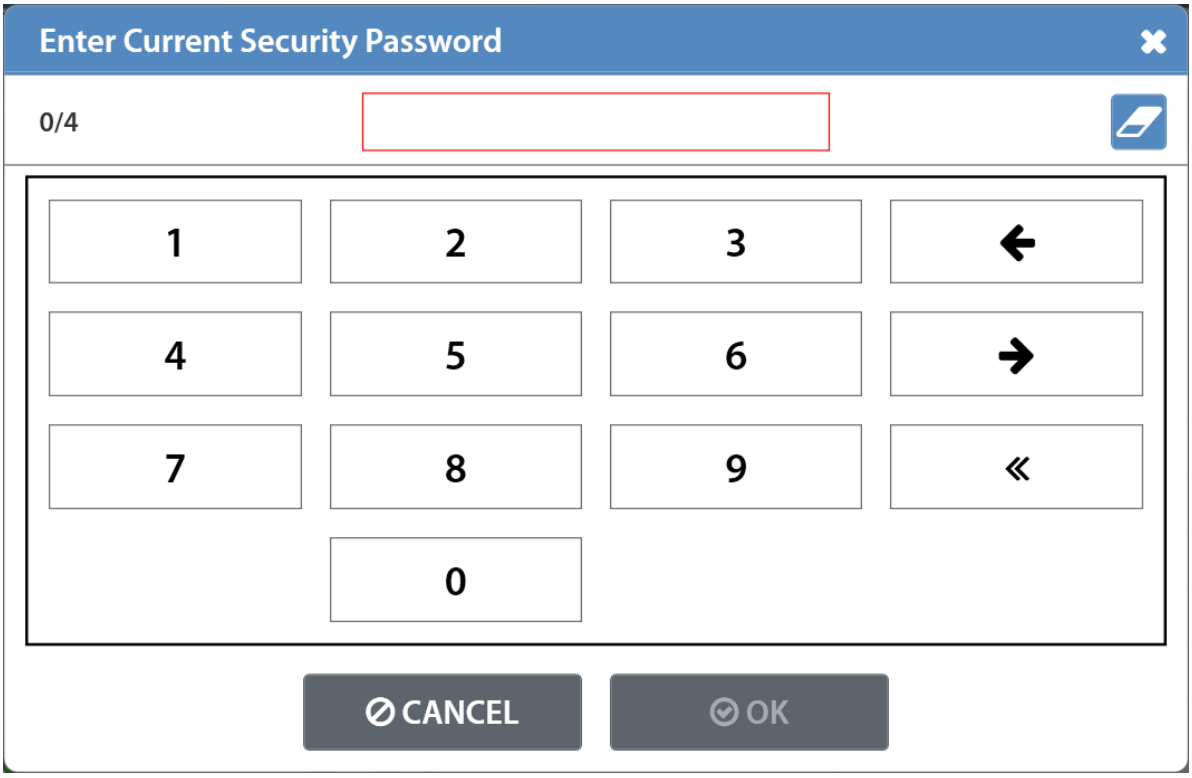


Security

Navigating to the Security menu under the Global Config tab will allow you to set a password for your MH instrument(s) as well as secure various features and functions of the instrument(s).



Whenever a secured feature or function is accessed, the user will be prompted to enter the security password.

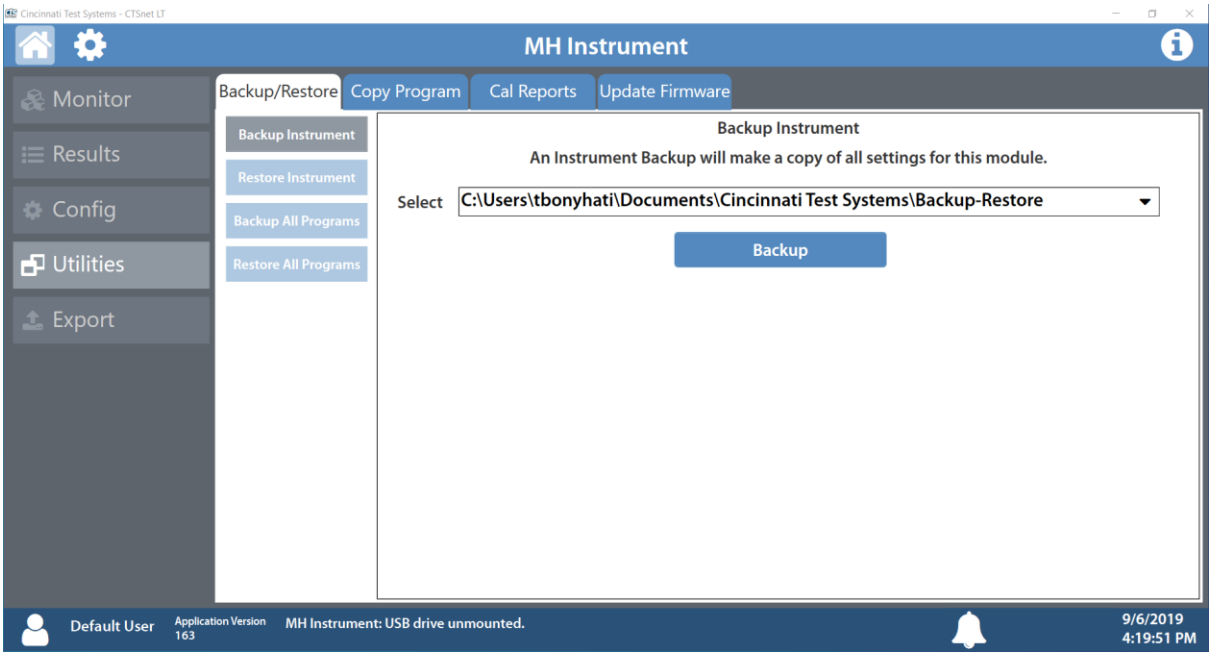


Utilities Screen

Backup/Restore Instrument Tab

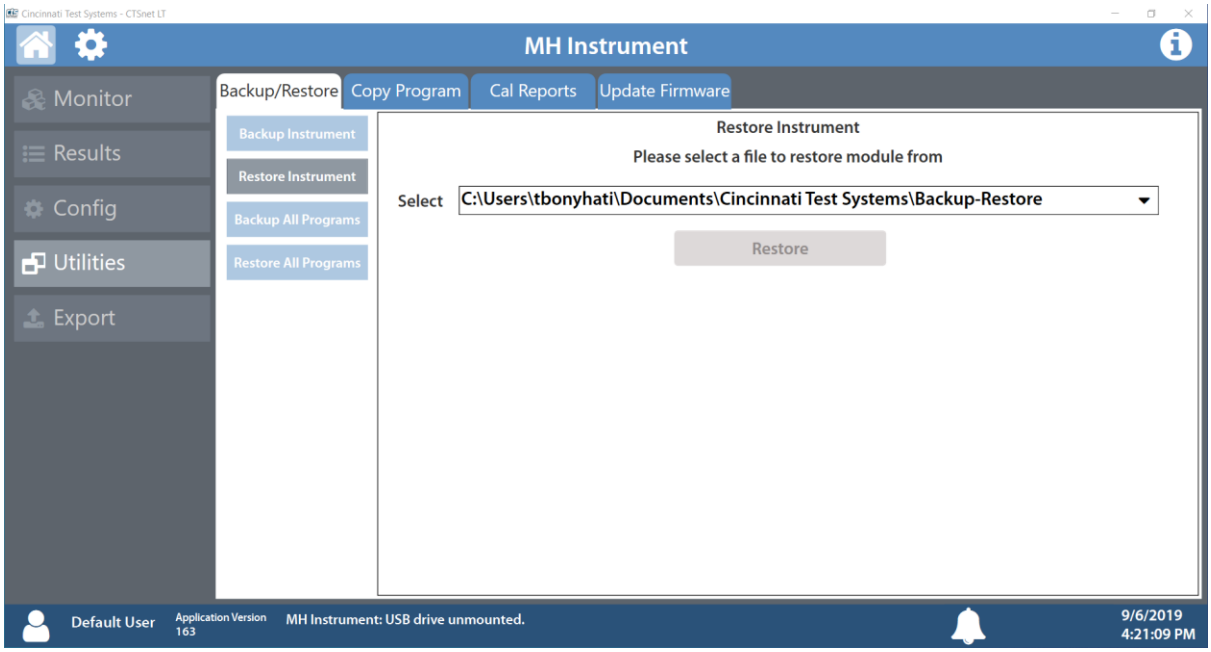
Backup Instrument

Navigating to the Backup Instrument menu under the Backup/Restore tab will allow you to select a folder location to create a backup file.



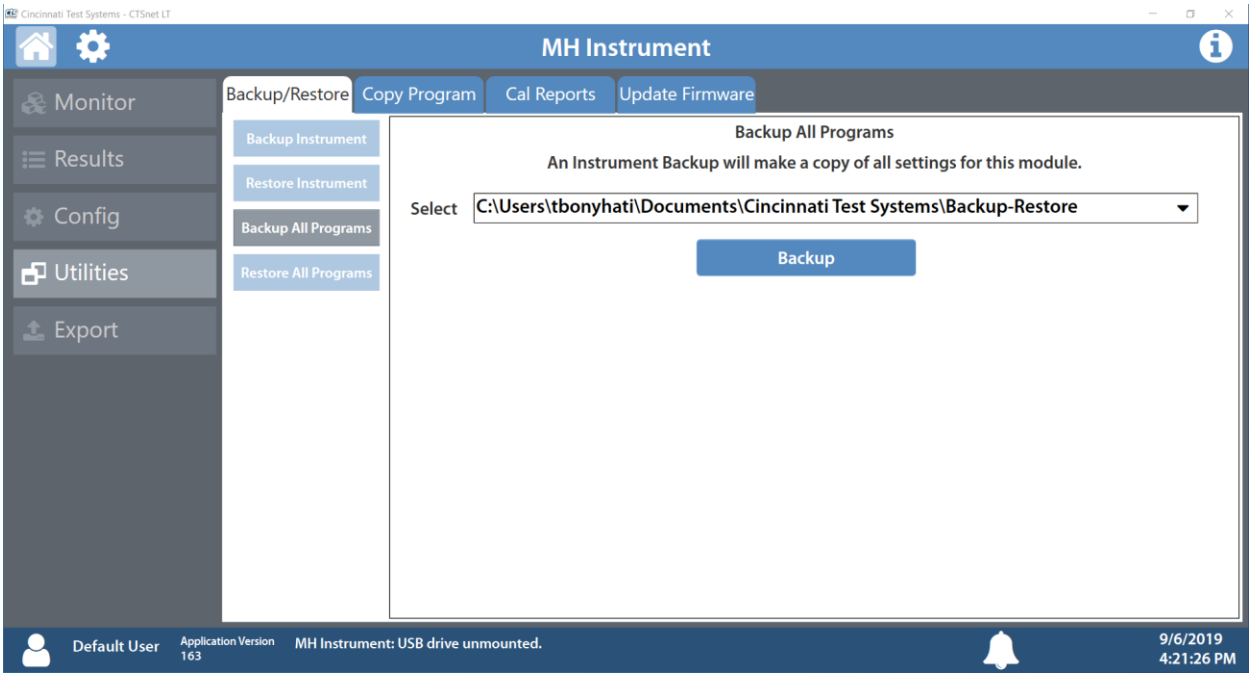
Restore Instrument

Navigating to the Restore Instrument menu under the Backup/Restore tab will allow you to select a file from a folder location to restore a backup file.



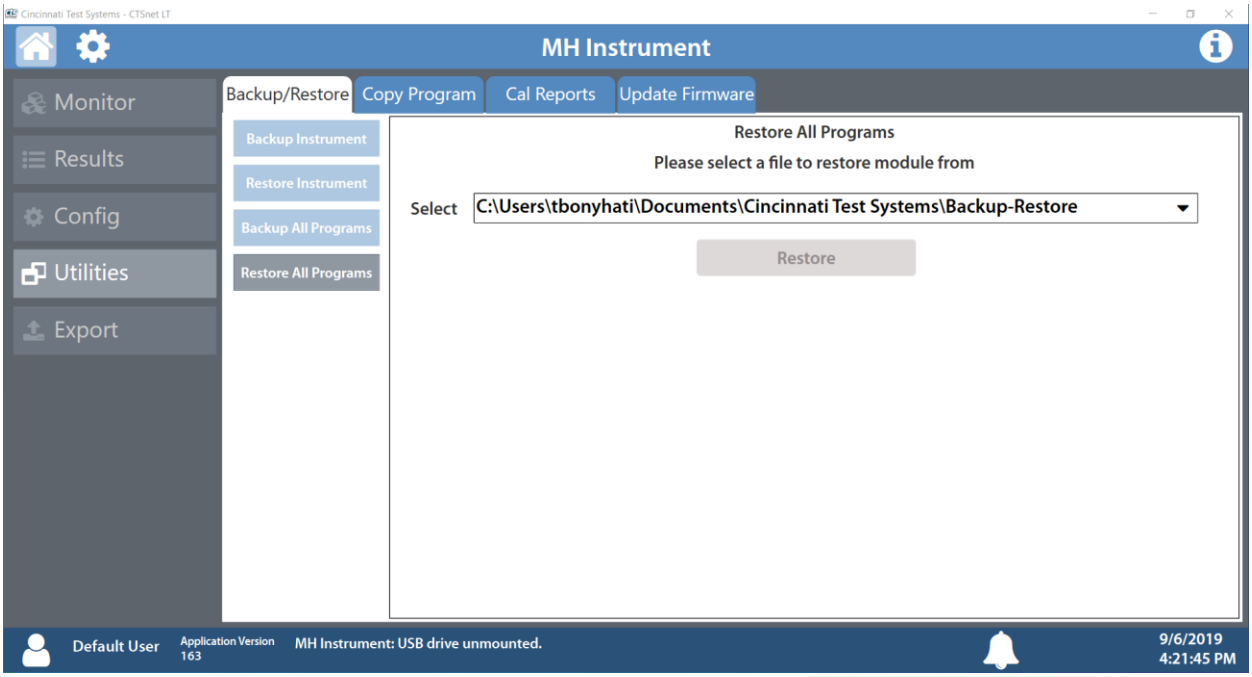
Backup All Programs

Navigating to the Restore All Programs menu under the Backup/Restore tab will allow you to select a folder location to create a backup of all the configured programs on your MH instrument(s).



Restore All Programs

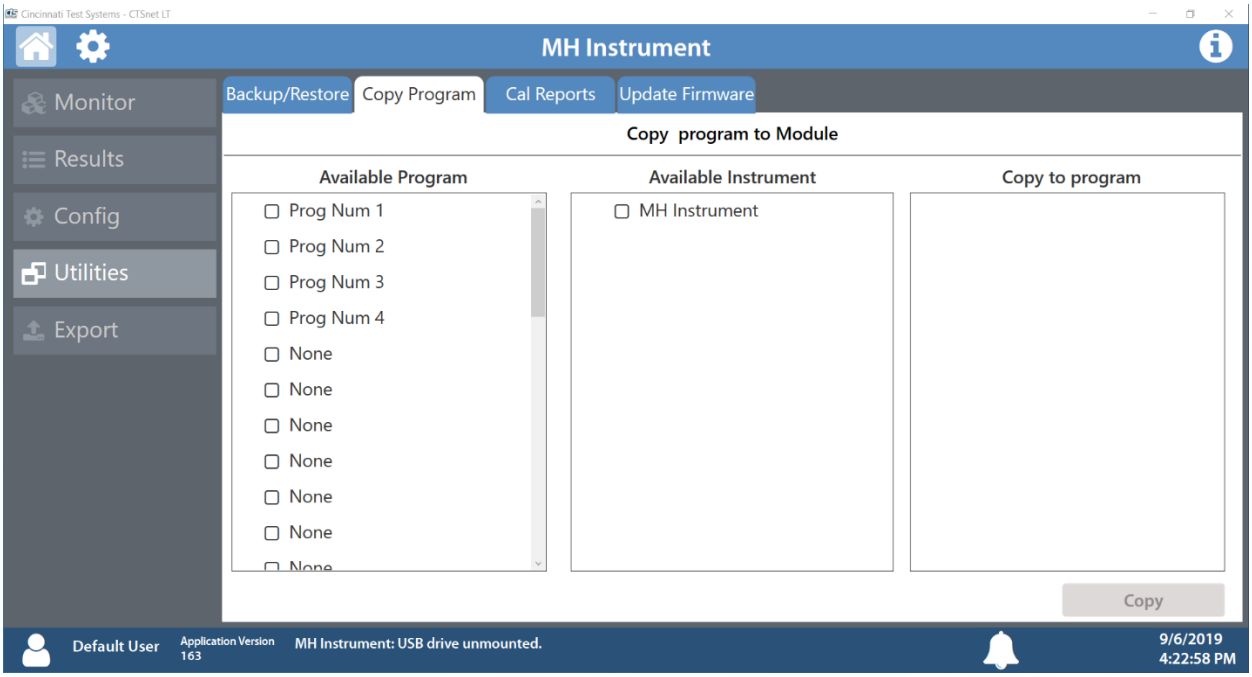
Navigating to the Restore All Programs menu under the Backup/Restore tab will allow you to select a file from a folder location to restore of all the configured programs on your MH instrument(s).



Copy Program Tab

The Copy Program tab will allow you to copy any available program to one or more instruments.

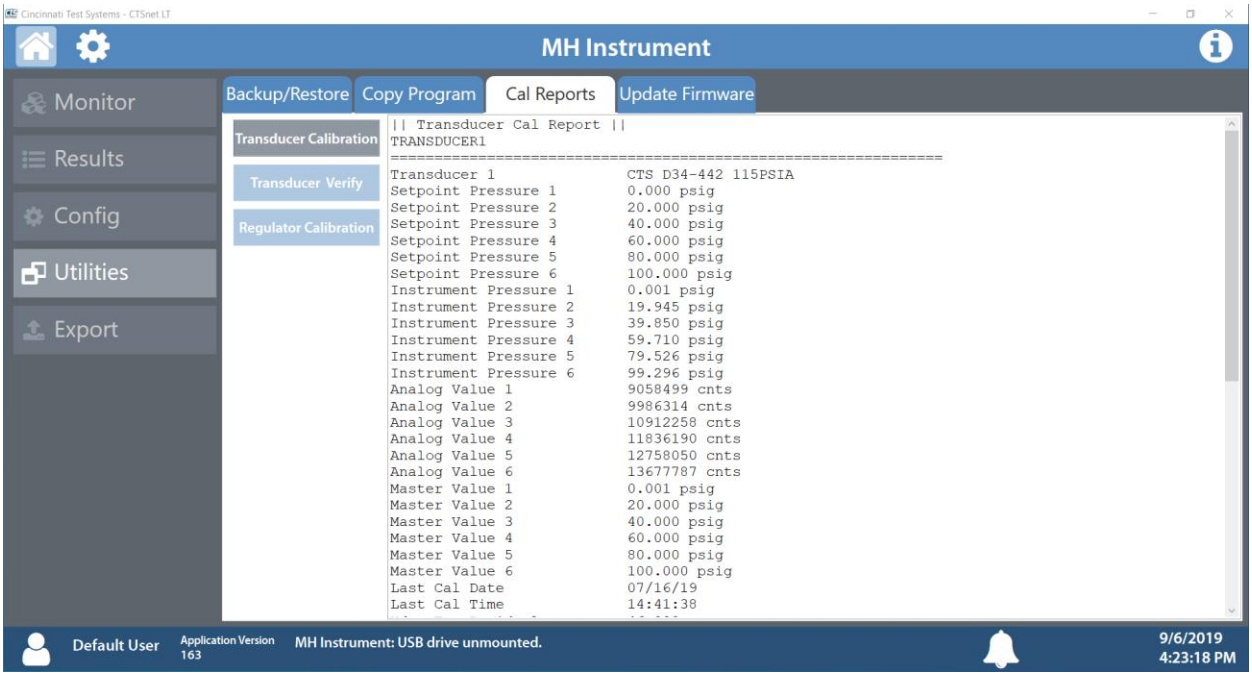
1) Select the program you wish to copy from the list of available programs.
2) Select the instruments you wish to copy them to.
3) Select the program you wish to overwrite with the copied program and press Copy



Cal Reports Tab

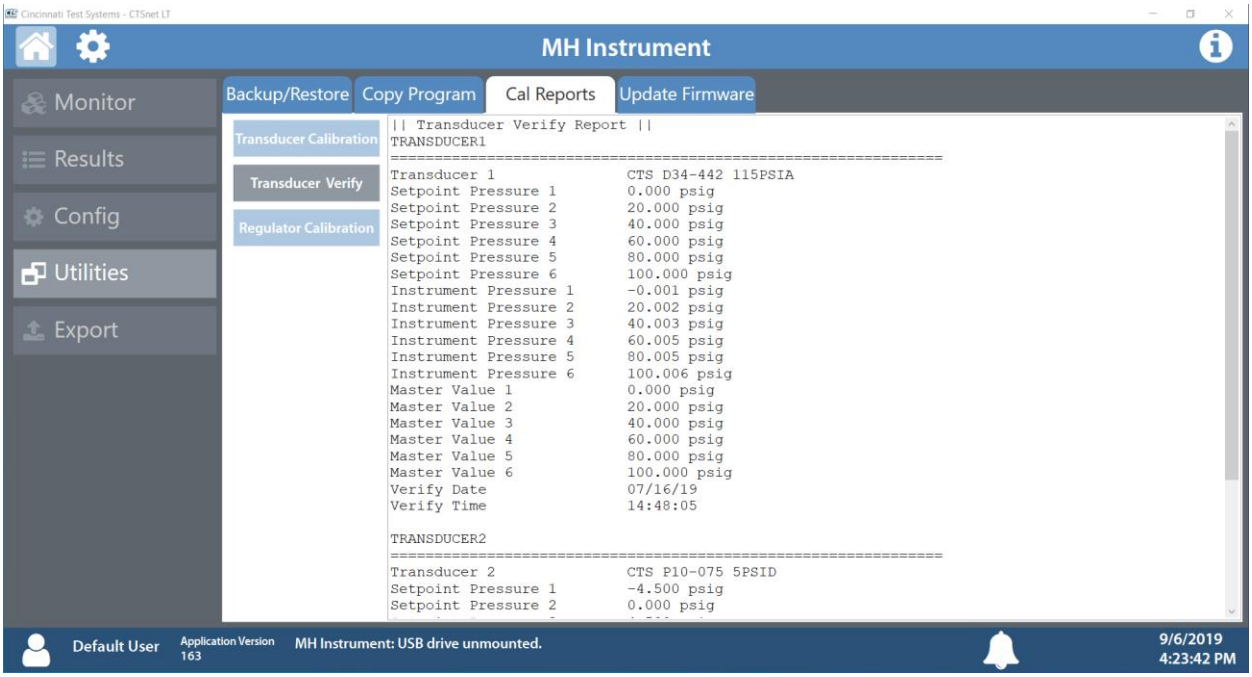
Transducer Calibration

Navigating to the Transducer Calibration menu under the Cal Reports tab will allow you to view the calibration results for all available transducers.



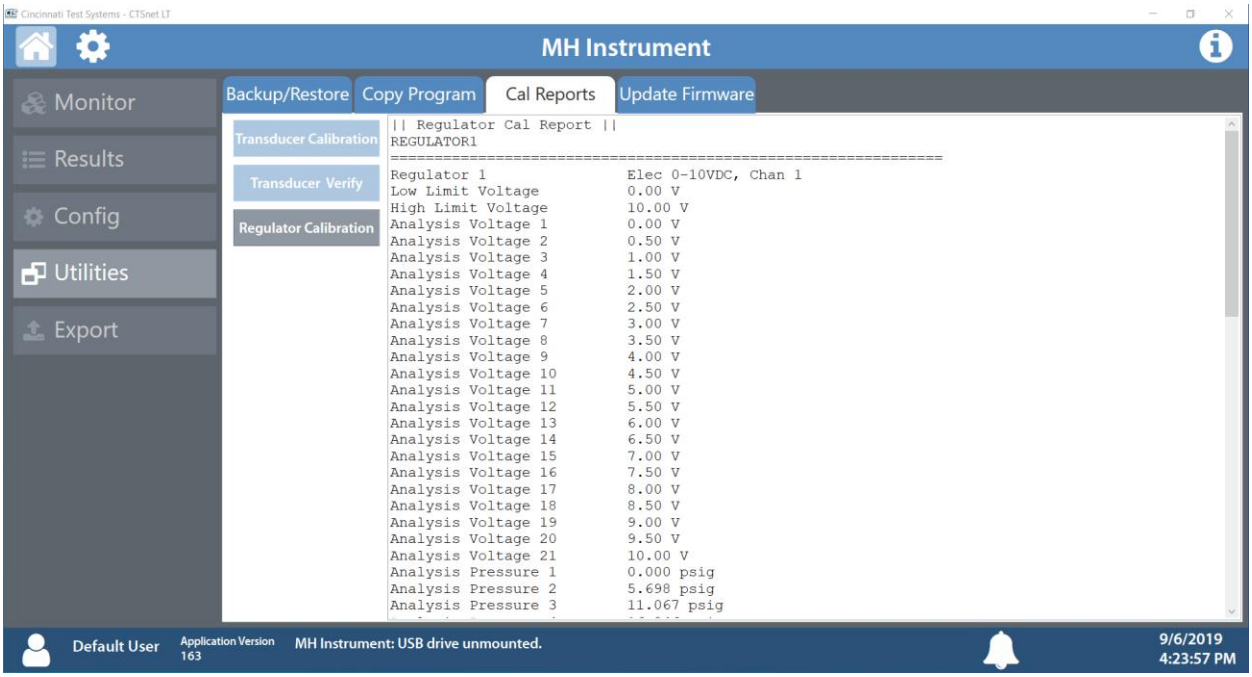
Transducer Verify

Navigating to the Transducer Verify menu under the Cal Reports tab will allow you to view the verification results for all available transducers.



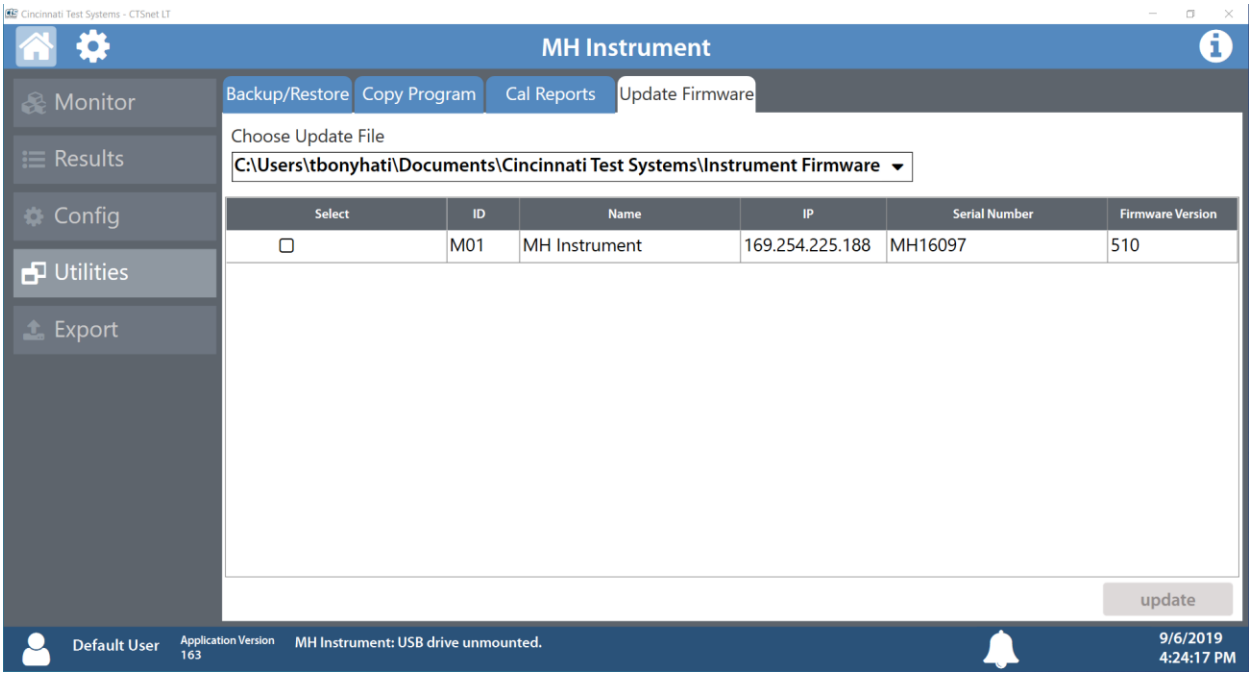
Regulator Calibration

Navigating to the Regulator Calibration menu under the Cal Reports tab will allow you to view the calibration results for the electronic regulator (if available).



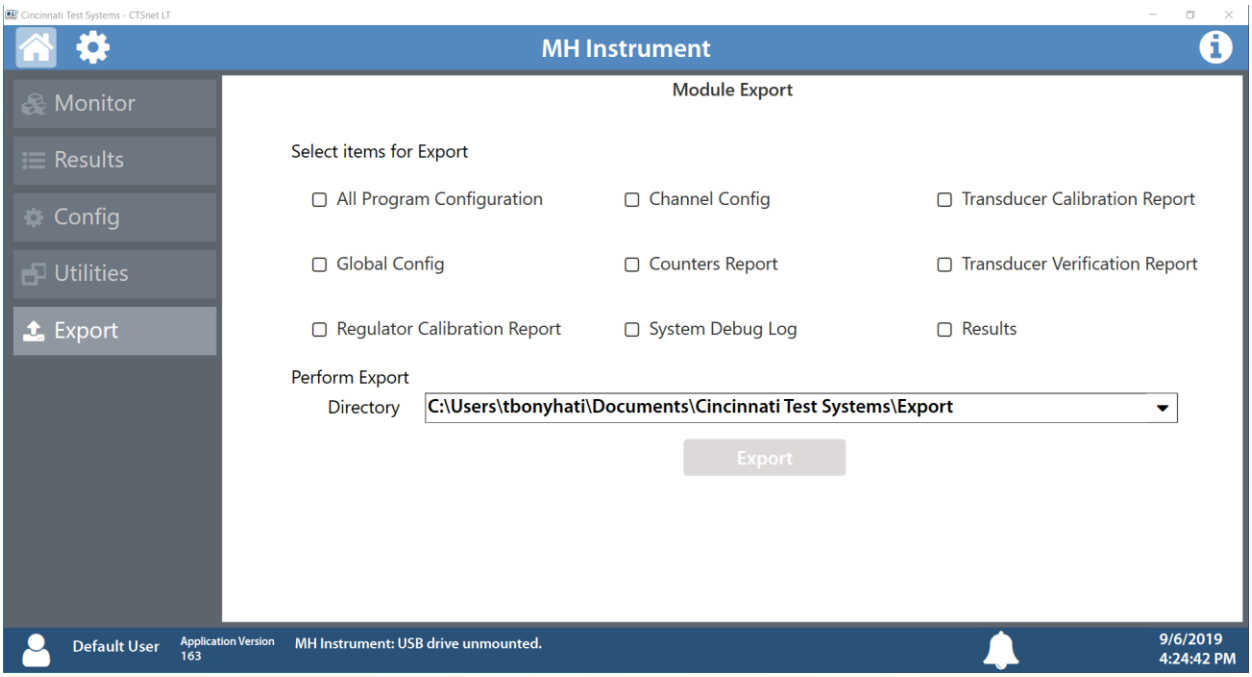
Update Firmware Tab

This tab will allow you to update the firmware of your MH instrument(s) from a selected file.
Note: This should only be performed with CTS service guidance. Refer to Chapter 15 – Features for more information.



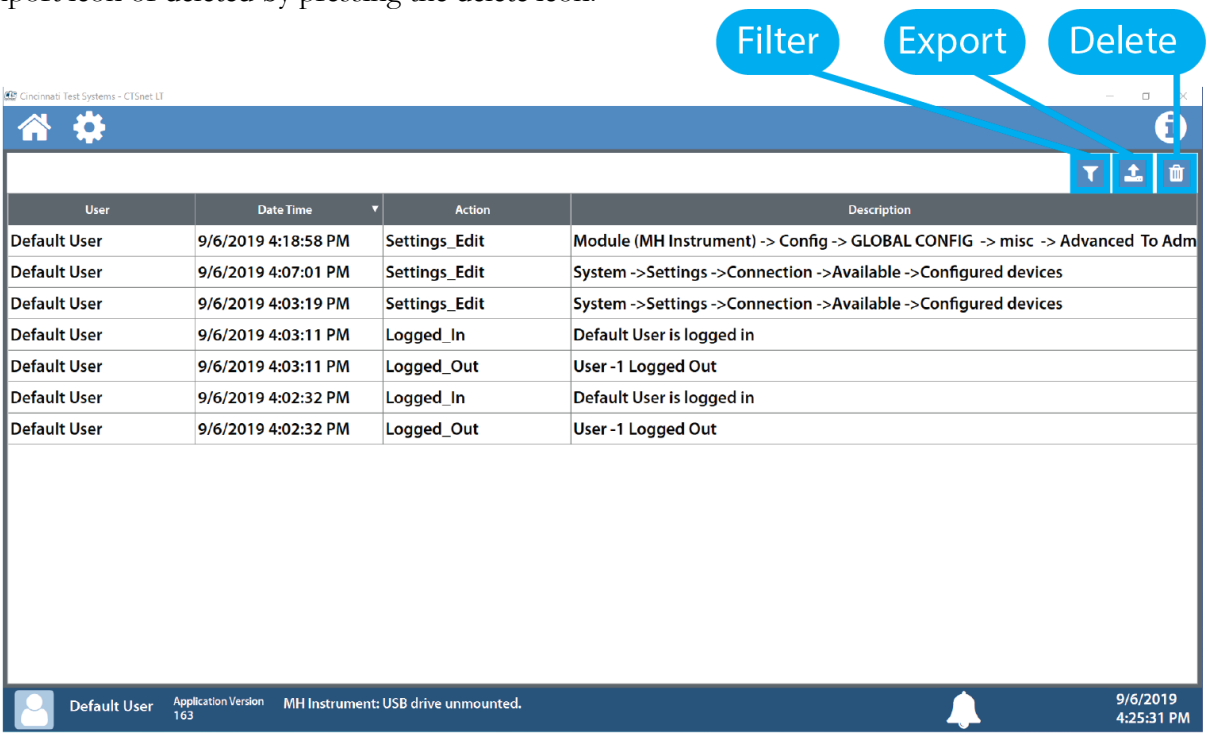
Export Screen

The Export section will allow you to export a variety of reports and results as .txt files. You can also export a System Debug Log to send to CTS for service needs.



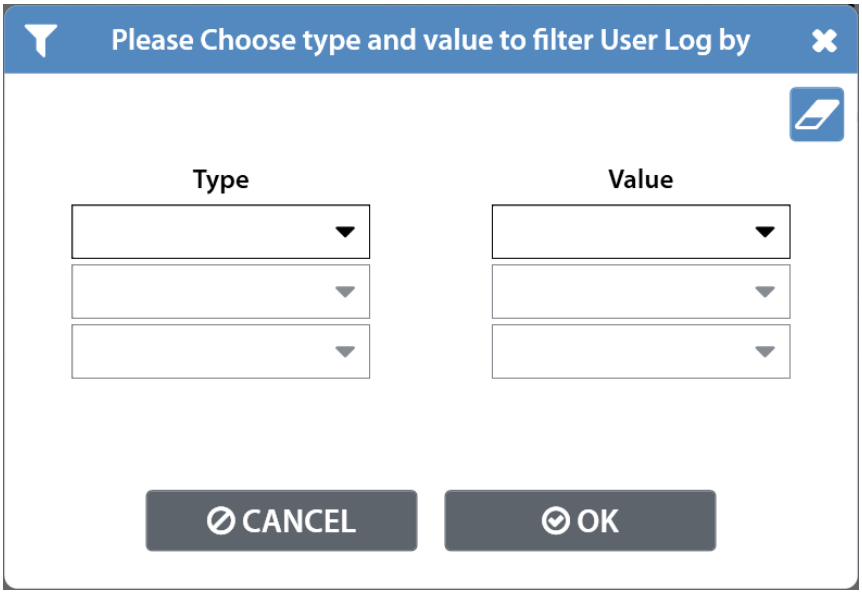
Users Screen

Pressing the user icon on the bottom left of the screen will display a log of user actions along with a description of the action. This log can be filtered by pressing the filter icon, exported by pressing the export icon or deleted by pressing the delete icon.



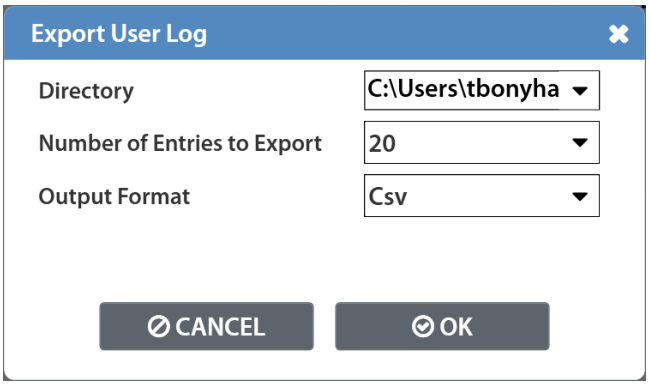
Filtering User Log

You can create up to 3 filters to sort user logs.

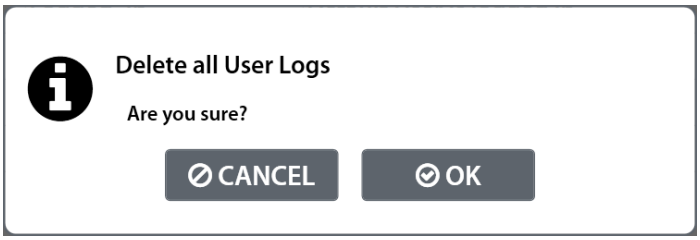


Exporting User Log

When exporting the user log, select a folder to export to, the number of entries and the output format.

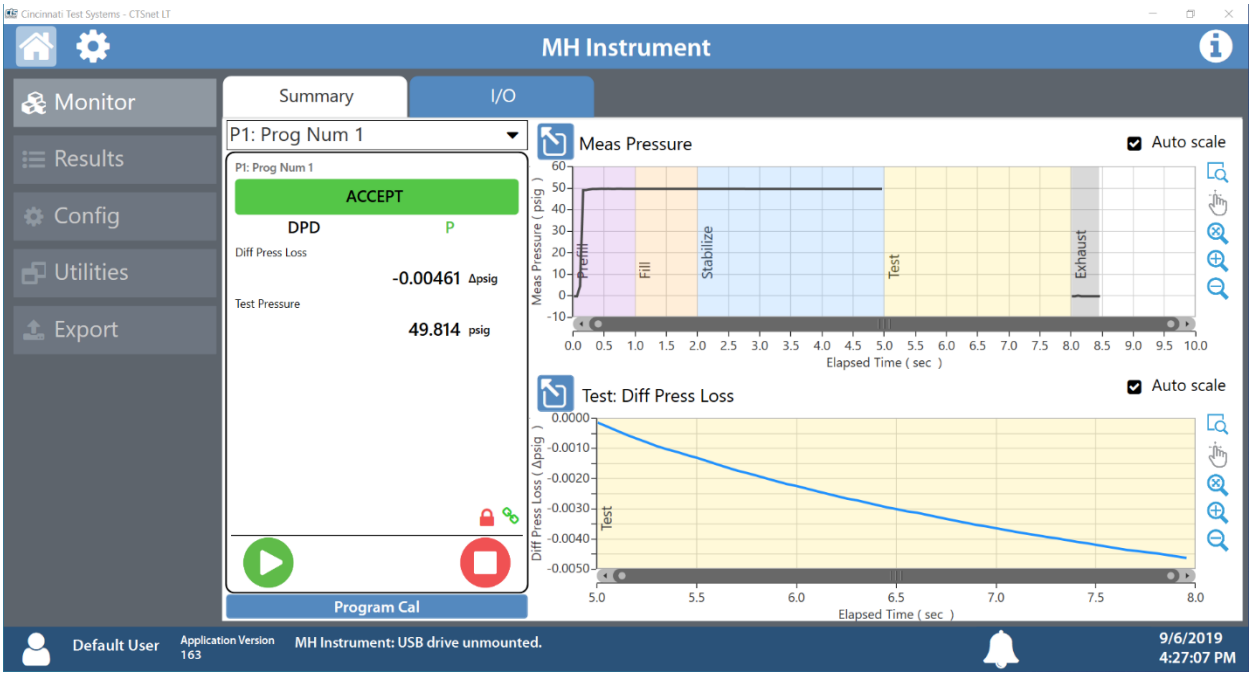


Deleting User Log

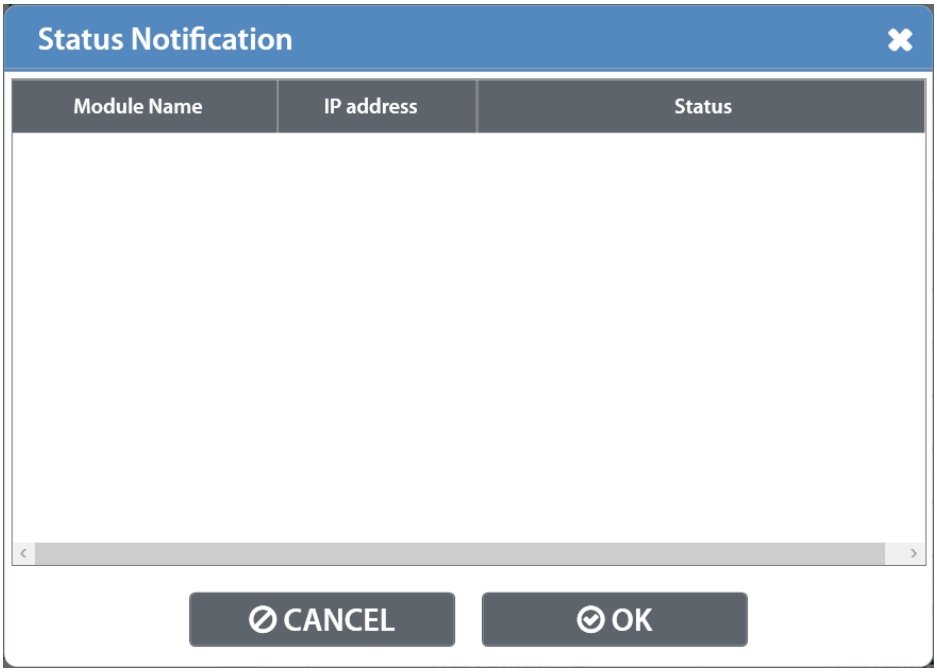


Status Notification

Pressing the bell icon on the bottom of the screen will display the status notification screen. The bell icon will display green for success in connecting or red for an error when a notification appears. It will also display the number of notifications if there are multiple.



The Status Notification pop-up will clear the notifications upon pressing the OK button.



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Chapter 3 – Setup

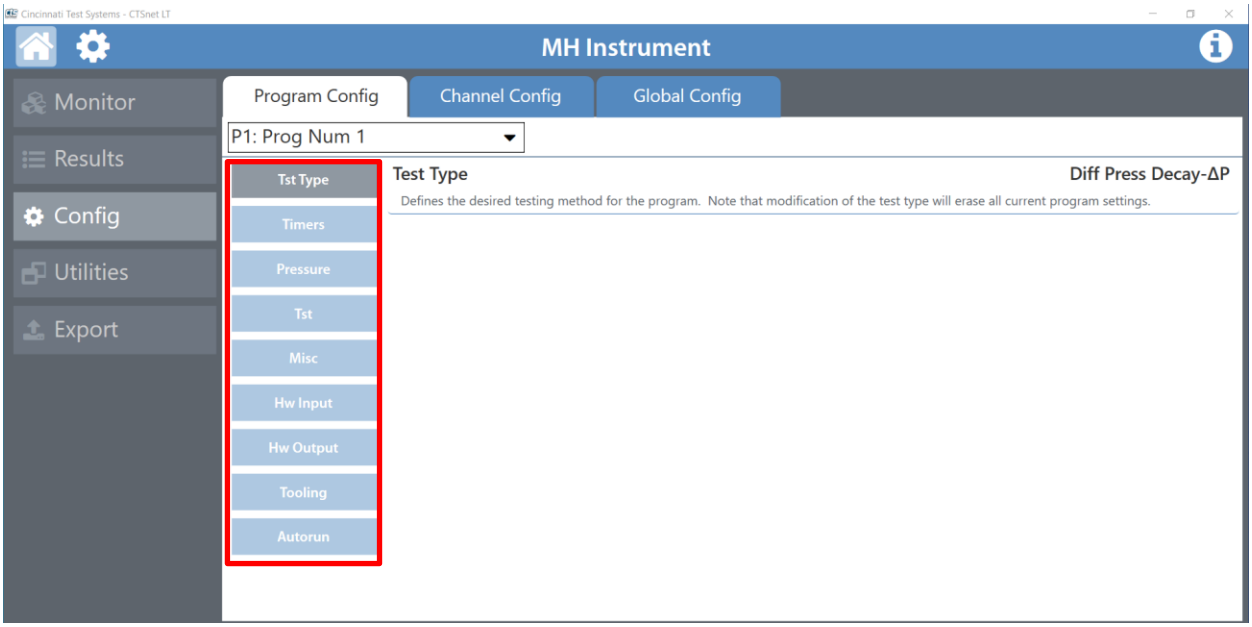
In this chapter, you are asked how you plan to use the instrument to conduct the test or sequence of tests for the intended application. Based on the answers, you will be directed to modify certain instrument settings.

Setting up the instrument to meet specific application requirements is most effectively accomplished by answering a few questions. These questions will guide you through the initial stages of the setup and point you to the appropriate chapters that detail specific instructions based on the answers.

It is highly recommended that each type of part being tested, whether they differ in volume or construction, have their own set of parameters defined in the instrument using individual Programs. Pressure decay leak testing is a volume dependent function. In certain cases, it is possible to group similar parts together to use the same parameters. In this case we recommend you talk to a CTS applications specialist to assure proper functionality.

Selection of Test Types

The first step in setting up the instrument is to select the type of test you want to conduct from the pre-packaged test sequences. Repeating this step under a different program number will enable you to configure up to 32 different test configurations. The **Test Type Table** on the following page includes the different test types available in the instrument, a brief description, and the associated chapter that details the pre-packaged test program. The availability of these test types is based on the hardware configuration of the instrument.



Use the dropdown menu to select a program to edit and the highlighted parameters to edit it.

Test Type Table

Test Type	Description
Diff Pressure (DP)-ΔP Chapter 4	Measures the Differential Pressure Loss (ΔP) between the test part and the reference volume over a fixed time. Determined from the pressure loss over the duration of the test timer. The result is presented in units of delta pressure.
Diff Pressure Decay (DP)-ΔP/ΔT Chapter 5	Calculates the Rate of Pressure Loss (ΔP/ΔT), determined from the differential loss between the test part and the reference volume, over unit time. The result is presented in units of delta pressure over delta time.
Diff Decay (DP)-Leak Rate Chapter 6	Calculates the Leak Rate determined from the differential loss between the test part and the reference volume over time, using the provided known part volume. The result is presented in the units of flow.
Diff Pressure (DP)-Leak Std Chapter 7	Calculates the Leak Rate determined from the differential loss between the test part and the reference volume over time, relating to the pressure loss of the leak standard and of the non-leaking master part. The result is presented in units of flow.
Occlusion Chapter 8	Measures the Back Pressure (part blockage). Determined from the pressure at the end of the test timer. The result is presented in units of pressure.

Before we begin setting the parameters of the program, we need to determine some of the capabilities and features required for the application.

Tooling Control

The instrument is capable of controlling tooling to possibly eliminate the need for a PLC or other computer that would control cylinders and sealing.

Question:

Are you planning to use the Sentinel MH to control any sealing operations?

Yes: It is important that you understand the concepts and safety requirements of Tooling Control. See Chapter 9 and then come back and continue the setup.

No: Proceed.

Programming the Inputs and Outputs

The instrument comes with 7inputs and 5 outputs (24VDC) that are user configurable for each program.

Question:

Are you planning to use the Sentinel MH to control any ancillary devices using discrete I/O or Ethernet/IP™ , or communicate with a PLC?

Yes: See Chapter 10 - Inputs and Outputs, Chapter 11 - Ethernet/IP, or Chapter 12 - Communication, and then come back and continue the setup.

No: Proceed.

Channel Configuration

Setting the Units of Measure

The instrument has the capability to utilize different units of measure for each configured program. In order to keep things simple and user friendly if you always use the same units of measure, you can set the units in one place and have them apply instrument wide. This is done in the Channel Configuration menu.

Question:

Are you planning to use the same units of measure for every program?

Yes: Press the Main Menu button, select the Channel Config tab, then select the Units tab. Change the Unit/Prec Define parameter to "Channel". Set the desired units of measure on that same screen. These units will apply to every program.

No: Press the Main Menu button, select the Channel Config tab, then select the Units tab. Change the Unit/Prec Define parameter to "Program". The Units tab will now appear under the Program Config menu. When a program is created, the units for the program will use the units under the Channel Config menu as the default settings but the units can now be changed per program.

Note: The units set on the Channel Config screen are also the units used for Self-Test, Auto Setup and transducer Set/Span routines.

Note: The precision displayed for each unit may also be set on this screen.

Setting the Leak Standard Values

The instrument has the capability to utilize different leak standards for each configured program that uses a leak standard. In order to keep things simple and user friendly if you always use the same leak standard, you can set the leak standard value and pressure in one place and have it applied instrument wide to any program that uses a leak standard. This is done in the Channel Configuration menu.

Question:

Are you planning to use the same leak standard for every program that requires a leak standard?

Yes: Press the Main Menu button, select the Channel Config tab, then select the Leak/Cal tab. Change the Leak Std/Cal Define parameter to "Channel". Set the leak standard value and the pressure at which it was calibrated on that same screen. This leak standard value will apply to every program that utilizes a leak standard for calibration.

No: Press the Main Menu button. Select the Channel Config tab. From the Channel Config menu select the Leak/Cal tab. Change the Leak Std/Cal Define parameter to "Program". The leak standard parameters will now appear on the TST: * screen under the Program Config menu. When a program is created, the units for the program will use the leak standard value under the Channel Config menu as the default settings but now can be changed per program.**

Note: Every time the leak standard value changes due to a calibration or when a new leak standard is used this value needs to be modified to reflect the new value.

Note: The parameter that determines where the physical leak standard is located (either inside the instrument or connected to a port on the outside) is also located in the Leak/Cal menu or the TST menu. However, to view this parameter you must be in the Display User Level. To change the Display User Level, see Chapter 15 *– Features.*

Remember: Press the information button and select a parameter you would like to know more about.

Program Configuration

Now that you have created a program, configured the tooling and associated I/O, and set the channel level parameters, it is time to set the regulators to the correct test pressure.

Pressure Select

To select the proper source for the test, we need to inform the instrument which regulator to use for this program. This is located in **Main Menu > Program Config > Misc** tab. The parameter called Pressure Select will need to be set to match the proper source. Instruments with only one pressure source will not allow editing of the Pressure Source parameter.

Setting the Pneumatic Regulator

Question:

Does the pressure source you are using for this program have an electronic regulator?

Yes: The electronic regulator has been setup and calibrated at the factory and is ready to use. For calibrating the electronic regulator, see Chapter 16 **– Instrument Calibration.**

No: Setting a mechanical pressure regulator is done in the Channel Config screen under the Set/Span menu. In order to set the regulator, the test port will need to be blocked which will allow the instrument to hold pressure. Standard units are supplied with a quick connect fitting with an attached Self-Test cap. If this instrument is not a standard setup this may be done with a plug put in the test port. For proper plug thread specifications, consult the print set shipped with your instrument.

Setting the Test Parameters

It is time to set the test parameters to fit your application. Refer to the chapter that is associated with the test type chosen from Test Type Table earlier in this chapter.

Verifying Setup

Once you have everything programmed, run a repeatability study based on your company's quality standards to assure you are getting the results you desire.

Security

Now that the instrument is setup the way you want, make sure to lock down the parameters that you don't want changed until a key or password is used. See Chapter 14 – Security.

Backup the Instrument Settings

The setup of the instrument for one program is completed. You may now go back and setup multiple programs. Once you have completed, it is highly recommended that you save a backup of the instrument on a (FAT32) USB memory stick. For Instrument Backup and Restore see Chapter 15 – Features.

Chapter 4 – Differential Pressure (DP) Decay-ΔP

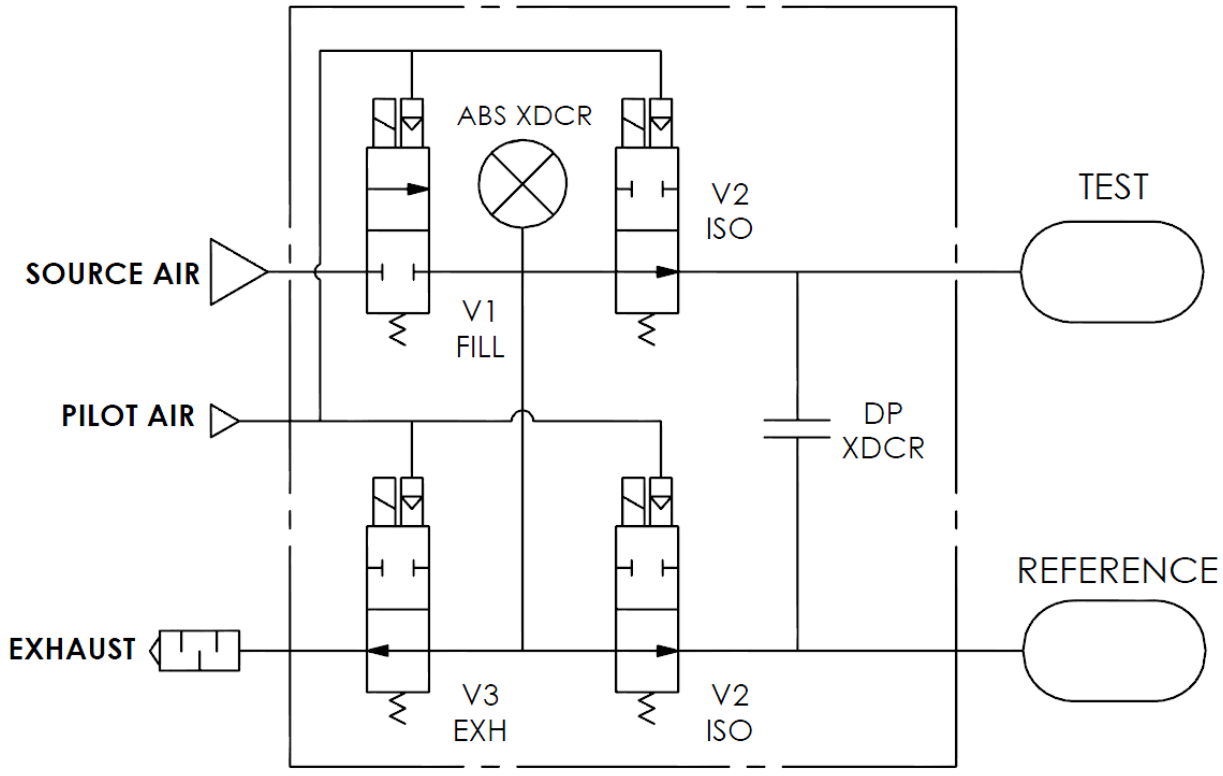
This chapter explains the theory and parameters for conducting a pressure decay test measuring a pressure loss over time utilizing a Differential Pressure (DP) transducer. The result of this test is the pressure loss (or gain for a vacuum test) measured over a fixed period of time, presented in units of pressure.

How it works

In order to detect leakage in a part, the change in pressure due to temperature and part elasticity must be allowed to settle before taking any pressure readings.

With differential pressure, a reference part volume (should be identical to the nominal test part volume) is pressurized simultaneously with the test part. A reference volume is <u>not</u> required, and the reference port may be capped when not used.

Leaks are determined by detecting the rate of pressure loss between the two parts.



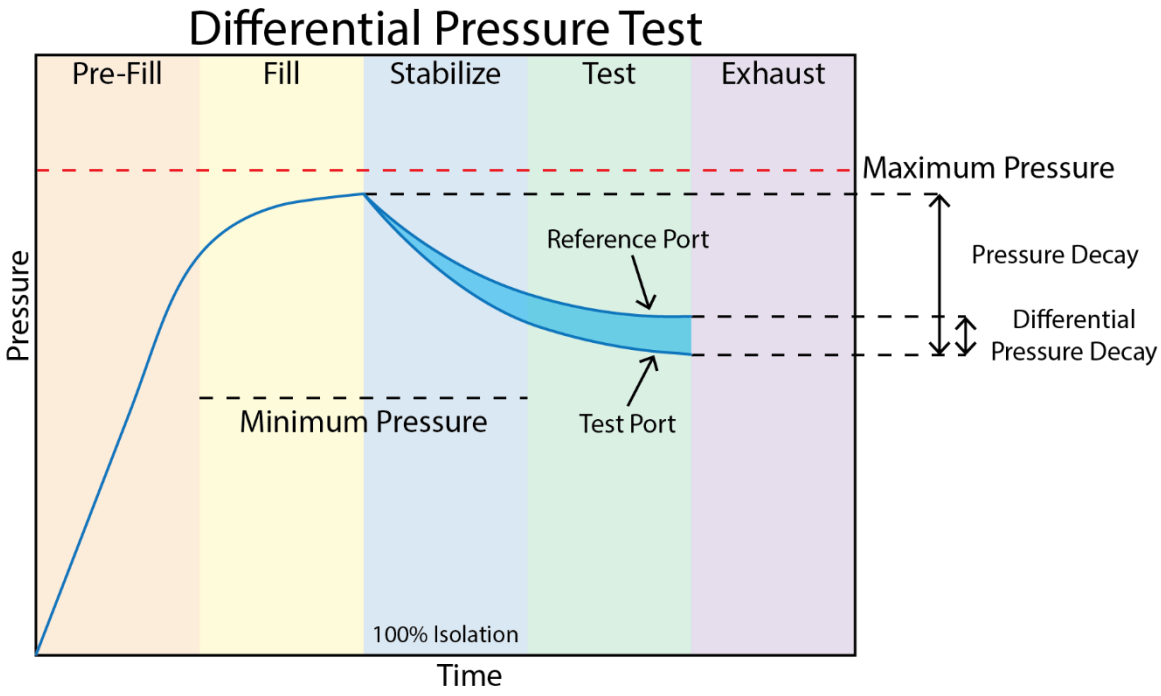
Test Setup

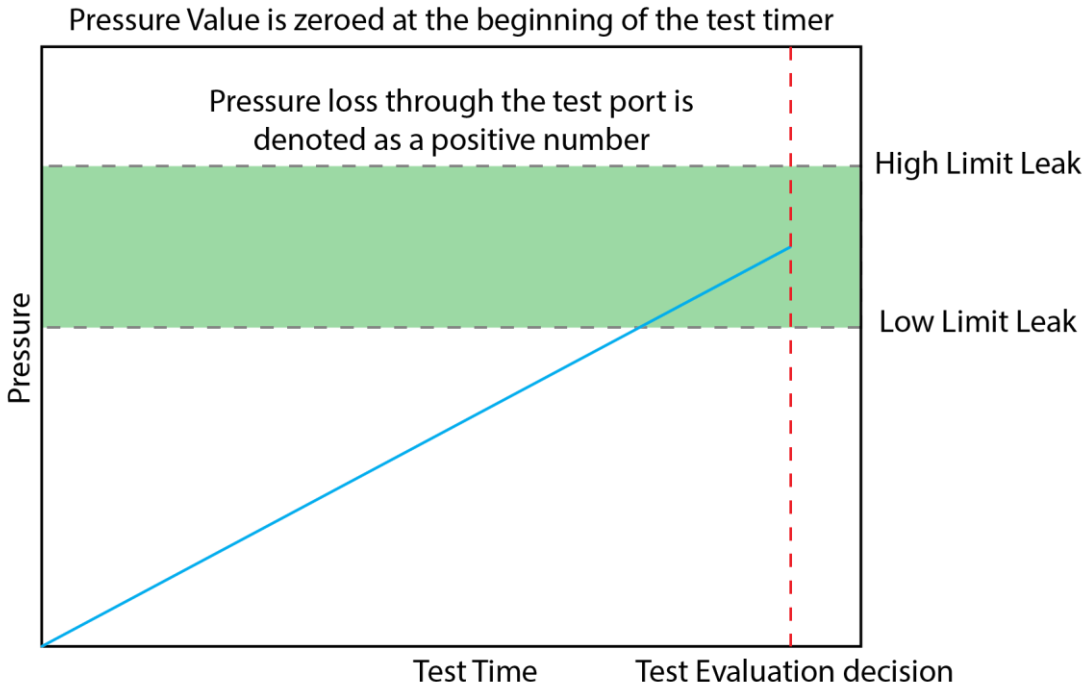
The test part and the reference volume are simultaneously pressurized to a preset pressure. The air in the system is then allowed to stabilize, with the supply valves all closed. After the stabilization time, the Differential Pressure Transducer is automatically zeroed.

During test, the pressure change in the test piece is compared to the pressure change in the reference volume, using the Differential Pressure Transducer. If the test piece is leaking, the difference will increase and be measured; an alarm limit may be set for a pass/fail decision.

The charts in this chapter give an overview of the parameters used to set up a Pressure Differential Test and correlate the results to a flow rate using a leak standard. The Tables that follow give detailed descriptions of each parameter and also document the Display User Level associated with each parameter.

Note: To change the Display User Level, see Chapter 15 ***– Features***.


Differential Pressure Test
Pre-Fill
Fill
Stabilize
Test
Exhaust
Maximum Pressure
Reference Port
Pressure Decay
Differential
Pressure Decay
Pressure
Minimum Pressure
Test Port
100% Isolation
Time


Pressure Value is zeroed at the beginning of the test timer
Pressure loss through the test port is
denoted as a positive number
High Limit Leak
Low Limit Leak
Pressure
Test Time
Test Evaluation decision

Timer Parameters

The Timers menu is located in the **Main Menu > Program Config > Timers** tab.

Timer	Description	User Display Mode
Tooling Extend	When tooling control is specified, there can be one extend timer for one tooling motion.	Basic Advanced, Admin
Prefill	Percentage of the fill timer where the minimum pressure limit is not monitored. This allows time within the fill stage for the instrument to achieve the minimum test pressure.	Advanced, Admin
Pre-Press	Time to enable part to reach the Pre-Pressure. At the end of this timer, the instrument will continue to the Fill segment and begin filling to the Target Pressure. *This parameter is only available if the Prefill Method selected is "Pre-Pressure Time"*	Basic Advanced, Admin
Charge	Time to enable part to reach the Charge Target Pressure. At the end of this timer, the instrument will read the pressure on the pressure transducer. *This parameter is only available if the Prefill Method selected is "Fixed Charge"*	Basic Advanced, Admin
Fill	Time to enable part to reach the Target Pressure. It may also be used as time to stabilize part pressure with additional air.	Basic Advanced, Admin
Isolation	Amount of stabilization time utilized to isolate the test part and reference volume prior to the test measurement.	Admin
Stabilize	Time to stabilize part pressure while isolated from the pressure regulator. This time directly affects the repeatability of the test.	Basic Advanced, Admin
Test	At the end of this timer, the instrument will read the pressure on the differential pressure transducer. This pressure is due to the backpressure created in the pneumatic circuit and part.	Basic Advanced, Admin
Exhaust	Time to relieve or vent part pressure before signaling the end of test. Need time to prevent blowing out debris or fixture seals.	Basic Advanced, Admin
Tooling Retract	When tooling control is specified, there can be one retract timer per tooling motion. This is a not to exceed timer when feedback is being utilized.	Advanced, Admin

Pressure Parameters

The Pressure menu is located in the **Main Menu > Program Config > Pressure** tab.

Pressure	Description	User Display Mode
Pre-Pressure	Target Pre-Pressure. Used as a setpoint for the Electronic Regulator during the Pre-Pressure time. *This parameter is only available if the Prefill Method selected is "Pre-Pressure Time"*	Basic Advanced, Admin
Pre-Pressure Window	The percentage (plus and minus) about the Pre-Pressure value defining the minimum and maximum pressure at the end of the Pre-Pressure time. *This parameter is only available if the Prefill Method selected is "Pre-Pressure Time"*	Basic Advanced, Admin
Minimum Pressure	Minimum test pressure that must be met within the Pre-fill timer and maintained during the Fill and Stabilization timers. This is an early indication of a major leak	Basic Advanced, Admin
Target Pressure	Target test pressure. Also used as a setpoint for the Electronic Regulator.	Basic Advanced, Admin
Maximum Pressure	The value that must not be exceeded at any time to complete a successful test. If the pressure goes above the Maximum Test Pressure, the testing cycle (during Fill and Stabilization) will end as an Over Pressure Malfunction.	Basic Advanced, Admin
Charge Min Press	Minimum charge pressure that must be met within the Charge timer and maintained before the Fill timer. This is an early indication of a major leak. If the pressure is measured below the Charge Min Press at end of Charge segment, the testing cycle will end as a Below Charge Malfunction. *This parameter is only available if the Prefill Method selected is "Fixed Charge"*	Basic Advanced, Admin
Charge Target Press	Target Charge pressure. Also used as a setpoint for the Electronic Regulator in Charge segment. *This parameter is only available if the Prefill Method selected is "Fixed Charge"*	Basic Advanced, Admin
Charge Max Press	The value that must not be exceeded at end of Charge segment. If the pressure is measured above the Charge Max Press at end of Charge segment, the testing cycle will end as an Above Charge Malfunction. *This parameter is only available if the Prefill Method selected is "Fixed Charge"*	Basic Advanced, Admin

Test Parameters

The Test parameters menu is located in the **Main Menu > Program Config > TST: DPD** tab.

TST Parameter	Description	User Display Mode
Low Limit Loss	Lower set point value used to evaluate test results.	Basic Advanced, Admin
High Limit Loss	Upper set point value used to evaluate test results.	Basic Advanced, Admin
Decay Direction	Defines the method for calculating the part pressure decay during test: Loss – charged part decreasing pressure or evacuated part decreasing vacuum, Gain – part pressure increasing from external forces.	Basic Advanced, Admin
Loss Offset	Manual compensation value which is added to the measured loss when calculating the final pressure loss for the test.	Basic Advanced, Admin
EDC Enabled	When enabled, Environmental Drift Correction (EDC) monitors and continually corrects final Leak Rate calculations based on the moving average shift of test results within a band about the Master Part calibration curve.	Advanced, Admin
EDC Percentage	Percentage (Plus and Minus) band defined by a percentage of High Limit about the Master Part Curve. EDC continually accumulates and calculates an offset for the test results.	Advanced, Admin
EDC Quantity	Number of test results utilized in calculating the EDC factor.	Advanced, Admin

Chapter 5 – Diff Pressure Decay-ΔP/ΔT

This chapter explains the theory and parameters for conducting a differential pressure decay test measuring the rate of change of a differential pressure loss over time. The result of this test is the rate of pressure change measured over the test time.

How it works

The basic principle of operation of a pressure decay leak test instrument is to fill the test part to a specified target test pressure, isolate the test part from the source air and allow the pressure to stabilize, and then measure the pressure loss due to a leak over a defined time, calculating the rate of loss.

The Charts below give an overview of the parameters used to set up a Diff Pressure Decay-ΔP/ΔT Test. The Tables that follow give detailed descriptions of each parameter and also document the Display User Level associated with each parameter.

Note: To change the Display User Level, see Chapter 15 ***– Features.***

Need Clarification on Graph

Timer Parameters

The Timers menu is located in the **Main Menu > Program Config > Timers** tab.

Timer	Description	Display User Level
Tooling Extend	When tooling control is specified, there can be up to five extend timers for up to five tooling motions. This is a not to exceed timer when feedback is being utilized.	Advanced, Admin
Prefill	Checks for excessively leaking parts or lack of pressure. May be set to "Percent of Fill Time" (default), for fixed fill time tests, or set to "Not to Exceed Time. For Changing the Functionality of the Prefill Timer, see Chapter 15 – Features. Maximum time to reach the minimum pressure. If the variable is set to "Not to Exceed Time", this segment will exit to the next once the Minimum Pressure value is reached.	Advanced, Admin
Pre-Press	Time to enable part to reach the Pre-Pressure. *This parameter is only available if the Prefill Method selected is "Pre-Pressure Time"*	Basic Advanced, Admin
Charge	Time to enable part to reach the Charge Target Pressure. At the end of this timer, the instrument will read the pressure on the pressure transducer.	Basic Advanced, Admin

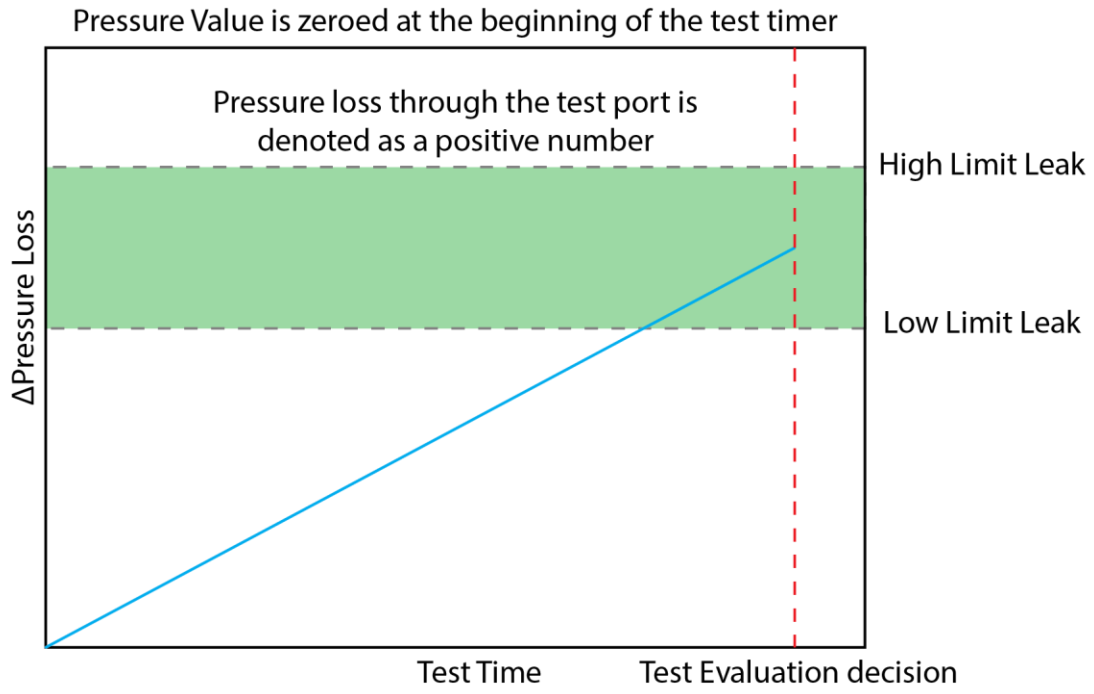
	This parameter is only available if the Prefill Method selected is "Fixed Charge"	
Fill	Time to enable part to reach the Target Pressure. It may also be used as time to stabilize part pressure with additional air.	Basic Advanced, Admin
Stabilize	Time to stabilize part pressure while isolated from the pressure regulator. This time directly affects the repeatability of the test.	Basic Advanced, Admin
Isolation	Amount of stabilization time utilized to isolate the test part and reference volume prior to the test measurement.	Admin
Test	The precise time over which to measure pressure drop or decay or the precise end time to measure pressure rise.	Basic Advanced, Admin
Exhaust	Time to relieve or vent part pressure before signaling the end of test. Need time to prevent blowing out debris or fixture seals.	Basic Advanced, Admin
Tooling Retract	When tooling control is specified, there can be up to five retract timers for up to five tooling motions. This is a not to exceed timer when feedback is being utilized.	Advanced, Admin

Pressure Parameters

The Pressure menu is located in the **Main Menu > Program Config > Pressure** tab.

Pressure	Description	User Display Mode
Pre-Pressure	Target Pre-Pressure. Used as a setpoint for the Electronic Regulator during the Pre-Pressure time. *This parameter is only available if the Prefill Method selected is "Pre-Pressure Time"*	Basic Advanced, Admin
Pre-Pressure Window	The percentage (plus and minus) about the Pre-Pressure value defining the minimum and maximum pressure at the end of the Pre-Pressure time. *This parameter is only available if the Prefill Method selected is "Pre-Pressure Time"*	Basic Advanced, Admin
Minimum Pressure	Minimum test pressure that must be met within the Pre-fill timer and maintained during the Fill and Stabilization timers. This is an early indication of a major leak	Basic Advanced, Admin
Target Pressure	Target test pressure. Also used as a setpoint for the Electronic Regulator.	Basic Advanced, Admin

Maximum Pressure	The value that must not be exceeded at any time to complete a successful test. If the pressure goes above the Maximum Test Pressure, the testing cycle (during Fill and Stabilization) will end as an Over Pressure Malfunction.	Basic Advanced, Admin
Charge Min Press	Minimum charge pressure that must be met within the Charge timer and maintained before the Fill timer. This is an early indication of a major leak. If the pressure is measured below the Charge Min Press at end of Charge segment, the testing cycle will end as a Below Charge Malfunction. *This parameter is only available if the Prefill Method selected is "Fixed Charge"*	Basic Advanced, Admin
Charge Target Press	Target Charge pressure. Also used as a setpoint for the Electronic Regulator in Charge segment. *This parameter is only available if the Prefill Method selected is "Fixed Charge"*	Basic Advanced, Admin
Charge Max Press	The value that must not be exceeded at end of Charge segment. If the pressure is measured above the Charge Max Press at end of Charge segment, the testing cycle will end as an Above Charge Malfunction. *This parameter is only available if the Prefill Method selected is "Fixed Charge"*	Basic Advanced, Admin



Test Parameters

The Test parameters menu is located in the **Main Menu > Program Config > TST:DDR** tab.

TST Parameter	Description	Display User Level
Low Limit Rate	Lower set point value used to evaluate test results.	Basic Advanced, Admin
High Limit Rate	Upper set point value used to evaluate test results.	Basic Advanced, Admin
Decay Direction	Defines the method for calculating the part pressure decay during test: Loss – charged part decreasing pressure, Gain – part increasing pressure from external forces.	Admin
EDC Enable	Activates Environmental Drift Correction. See Appendix C.	Advanced, Admin
EDC Percentage	See Appendix C.	Advanced, Admin
EDC Quantity	See Appendix C.	Advanced, Admin

Chapter 6 – Diff Decay-Leak Rate

This chapter explains the theory and parameters for conducting a Diff Decay-Leak rate test measuring leak rate by utilizing a Differential Pressure (DP) transducer. The result of this test is the leak presented in units of flow.

How it works

In order to detect leakage in a part, the change in pressure due to temperature and part elasticity must be allowed to settle before taking any pressure readings.

With differential pressure, a reference part volume (should be identical to the nominal test part volume) is pressurized simultaneously with the test part.

The Leak Rate is determined from the measured differential loss between the test port and the reference volume over time, using the provided known part volume. This test will NOT require calibration, and a Leak Standard is NOT required to determine the final leak rate.

The Leak rate is calculated by the following formula,

$$Q = \left(\frac{\Delta P}{\Delta t} \times \frac{V_{inst} + V_{part}}{P_{std}} \times 60.0\right) + Offset_{EDC} + Offset_{Leak\ Rate}$$

Where:

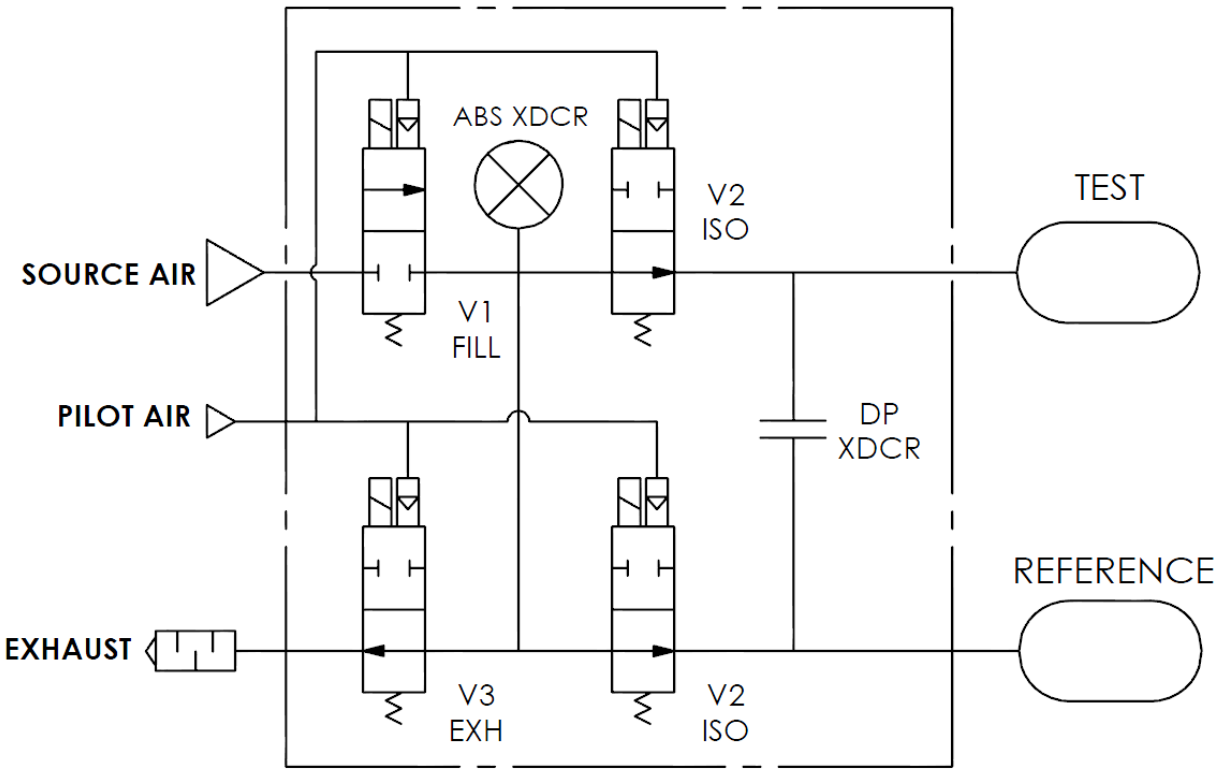
Q = Leak Rate

$\Delta P/\Delta t$ = Pressure Loss over time

P_{std} = **Standard Pressure (14.696 psig)**. This parameter is configured matching Standard Pressure definition used for instrument and leak calculation

V_{inst} = **Instrument Volume**. Volume of the instrument's isolated pneumatic circuit up to the test port. This parameter can be located at *Main Menu->Channel Config->Hardware*.

V_{part} = **Part Volume**.



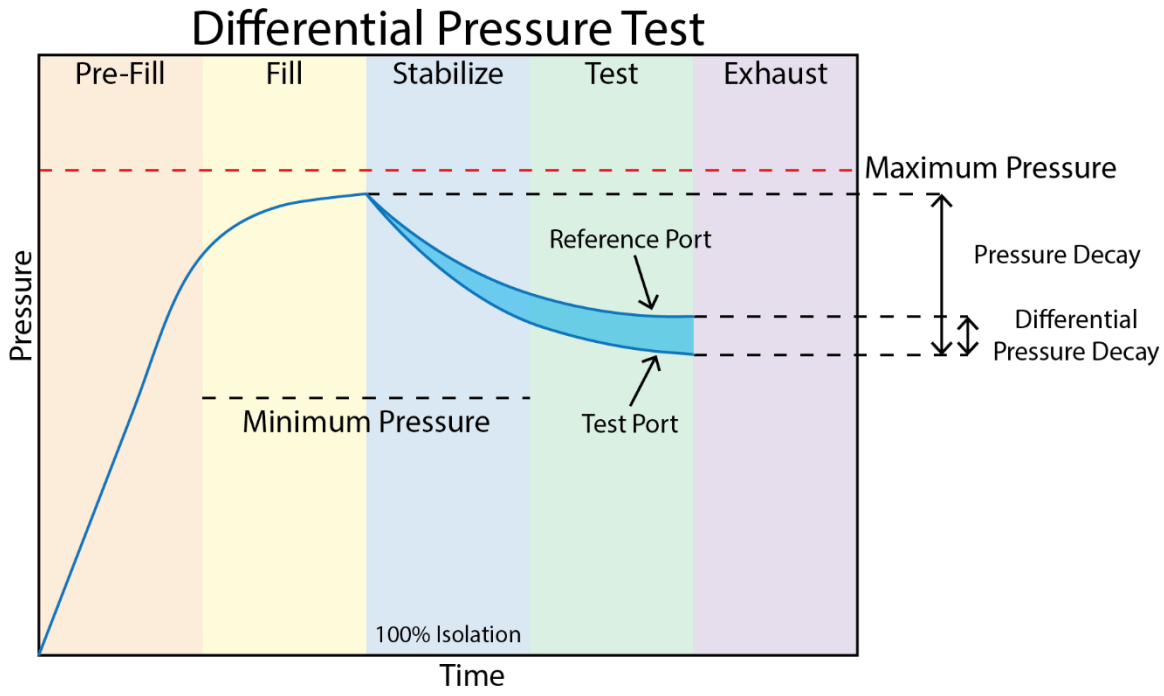
Test Setup

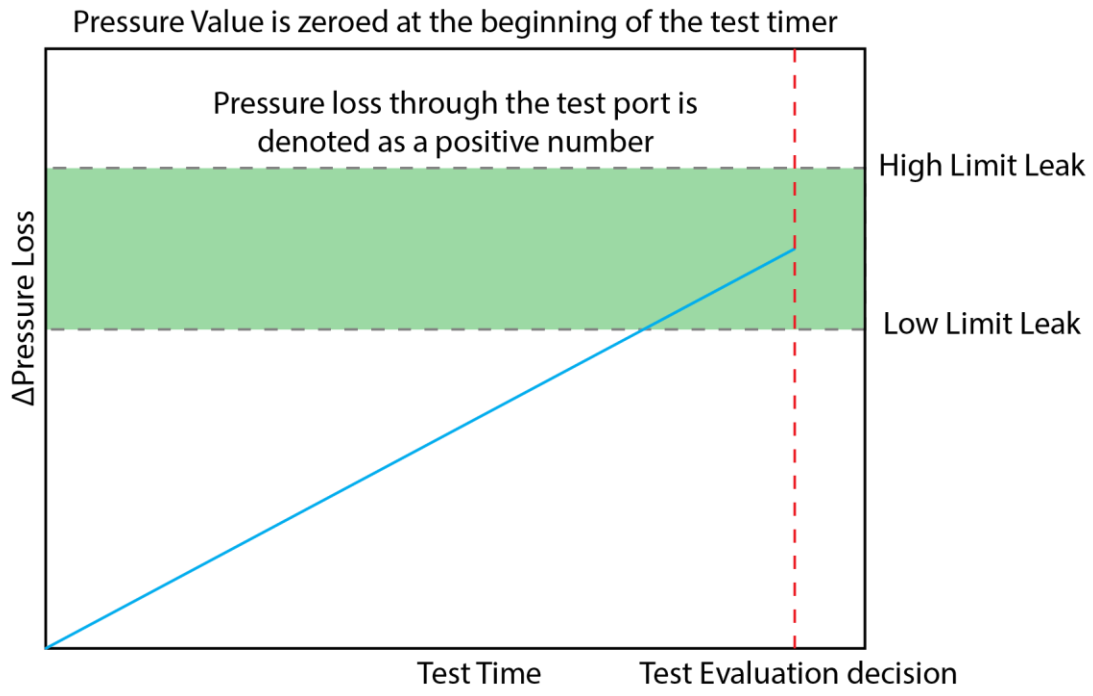
The test part and the reference volume are simultaneously pressurized to a preset pressure. The air in the system is then allowed to stabilize, with the supply valves all closed. After the stabilization time, the Differential Pressure Transducer is automatically zeroed. Before the beginning of the test measurement, the part and the reference volume are isolated from the supply valves for the time described in the Isolation parameter.

During test, the pressure change in the test piece is compared to the pressure change in the reference volume, using the Differential Pressure Transducer. If the test piece is leaking, the difference will increase and be measured; an alarm limit may be set for a pass/fail decision.

The Tables that follow give detailed descriptions of each parameter and also document the Display User Level associated with each parameter.

Note: To change the Display User Level, Chapter 15 ***– Features.***


Differential Pressure Test
Pre-Fill
Fill
Stabilize
Test
Exhaust
Maximum Pressure
Reference Port
Pressure Decay
Differential
Pressure Decay
Pressure
Minimum Pressure
Test Port
100% Isolation
Time


Pressure Value is zeroed at the beginning of the test timer
Pressure loss through the test port is
denoted as a positive number
High Limit Leak
Low Limit Leak
ΔPressure Loss
Test Time
Test Evaluation decision

Timer Parameters

The Timers menu is located in the **Main Menu > Program Config > Timers** tab.

Timer	Description	User Display Mode
Tooling Extend 1	When tooling control is specified, there can be one extend timer for one tooling motion.	Basic Advanced, Admin
Prefill	Percentage of the fill timer where the minimum pressure limit is not monitored. This allows time within the fill stage for the instrument to achieve the minimum test pressure.	Advanced, Admin
Pre-Press	Time to enable part to reach the Pre-Pressure. *This parameter is only available if the Prefill Method selected is "Pre-Pressure Time"*	Basic Advanced, Admin
Charge	Time to enable part to reach the Charge Target Pressure. At the end of this timer, the instrument will read the pressure on the pressure transducer. *This parameter is only available if the Prefill Method selected is "Fixed Charge"*	Basic Advanced, Admin
Fill	Time to enable part to reach the Target Pressure. It may also be used as time to stabilize part pressure with additional air.	Basic Advanced, Admin
Stabilize	Time to stabilize part pressure while isolated from the pressure regulator. This time directly affects the repeatability of the test.	Basic Advanced, Admin
Isolation	Amount of stabilization time utilized to isolate the test part and reference volume prior to the test measurement.	Admin
Test	At the end of this timer, the instrument will read the pressure on the pressure transducer. This pressure is due to the backpressure created in the pneumatic circuit and part.	Basic Advanced, Admin
Exhaust	Time to relieve or vent part pressure before signaling the end of test. Need time to prevent blowing out debris or fixture seals.	Basic Advanced, Admin
Tooling Retract 1	When tooling control is specified, there can be up to five retract timers for up to five tooling motions. This is a not to exceed timer when feedback is being utilized.	Advanced, Admin
Relax	Timer used during Program Cal routine as a delay between calibration cycles to allow the master part to recover to repeatable virgin state. (Too short relax times result in decreasing pressure losses/flow results in successive tests.)	Basic Advanced, Admin

Pressure Parameters

The Pressure menu is located in the **Main Menu > Program Config > Pressure** tab.

Pressure	Description	User Display Mode
Pre-Pressure	Target Pre-Pressure. Used as a setpoint for the Electronic Regulator during the Pre-Pressure time. *This parameter is only available if the Prefill Method selected is "Pre-Pressure Time"*	Basic Advanced, Admin
Pre-Pressure Window	The percentage (plus and minus) about the Pre-Pressure value defining the minimum and maximum pressure at the end of the Pre-Pressure time. *This parameter is only available if the Prefill Method selected is "Pre-Pressure Time"*	Basic Advanced, Admin
Minimum Pressure	Minimum test pressure that must be met within the Pre-fill timer and maintained during the Fill and Stabilization timers. This is an early indication of a major leak	Basic Advanced, Admin
Target Pressure	Target test pressure. Also used as a setpoint for the Electronic Regulator.	Basic Advanced, Admin
Maximum Pressure	The value that must not be exceeded at any time to complete a successful test. If the pressure goes above the Maximum Test Pressure, the testing cycle (during Fill and Stabilization) will end as an Over Pressure Malfunction.	Basic Advanced, Admin
Charge Min Press	Minimum charge pressure that must be met within the Charge timer and maintained before the Fill timer. This is an early indication of a major leak. If the pressure is measured below the Charge Min Press at end of Charge segment, the testing cycle will end as a Below Charge Malfunction. *This parameter is only available if the Prefill Method selected is "Fixed Charge"*	Basic Advanced, Admin
Charge Target Press	Target Charge pressure. Also used as a setpoint for the Electronic Regulator in Charge segment. *This parameter is only available if the Prefill Method selected is "Fixed Charge"*	Basic Advanced, Admin
Charge Max Press	The value that must not be exceeded at end of Charge segment. If the pressure is measured above the Charge Max Press at end of Charge segment, the testing cycle will end as an Above Charge Malfunction. *This parameter is only available if the Prefill Method selected is "Fixed Charge"*	Basic Advanced, Admin

Test Parameters

The Test parameters menu is located in the **Main Menu > Program Config > TST: DDL** tab.

TST Parameter	Description	User Display Mode
Low Limit Leak	Lower set point value used to evaluate test results of parts.	Basic Advanced, Admin
High Limit Leak	Upper set point value used to evaluate test results of parts.	Basic Advanced, Admin
Decay Direction	Defines the method for calculating the part pressure decay during test: Loss – charged part decreasing pressure, Gain – part increasing pressure from external forces.	Admin
Part Volume	Volume of the part under test. This should include the volume of all pressurized cavities of the part, seals, fittings and tubing leading up to the instrument's test port connection.	Basic Advanced, Admin
Leak Rate Offset	Manual compensation value which is added to the final calculated leak rate for the test.	Admin
EDC Enabled	When enabled, Environmental Drift Correction (EDC) monitors and continually corrects final Leak Rate calculations based on the moving average shift of test results within a band about the Master Part calibration curve.	Advanced, Admin
EDC Percentage	Percentage (Plus and Minus) band defined by a percentage of High Limit about the Master Part Curve. EDC continually accumulates and calculates an offset for the test results.	Advanced, Admin
EDC Quantity	Number of test results utilized in calculating the EDC factor.	Advanced, Admin

Chapter 7 – Differential Pressure (DP) Decay-Leak Std

This chapter explains the theory and parameters for conducting a Differential Pressure (DP) Decay Test with a Leak Standard. Pressure loss is measured utilizing a Differential Pressure (DP) transducer. The pressure loss is correlated to a leak rate using a leak standard. This test requires a two-cycle calibration routine to correlate the pressure loss to a flow rate. The result of this test is presented in units of flow.

This test type utilizes a two-point calibration sequence with a non-leaking master part to record the zero leak pressure loss value and the additional pressure loss value due to the flow rate of the leak standard on the second calibration cycle.

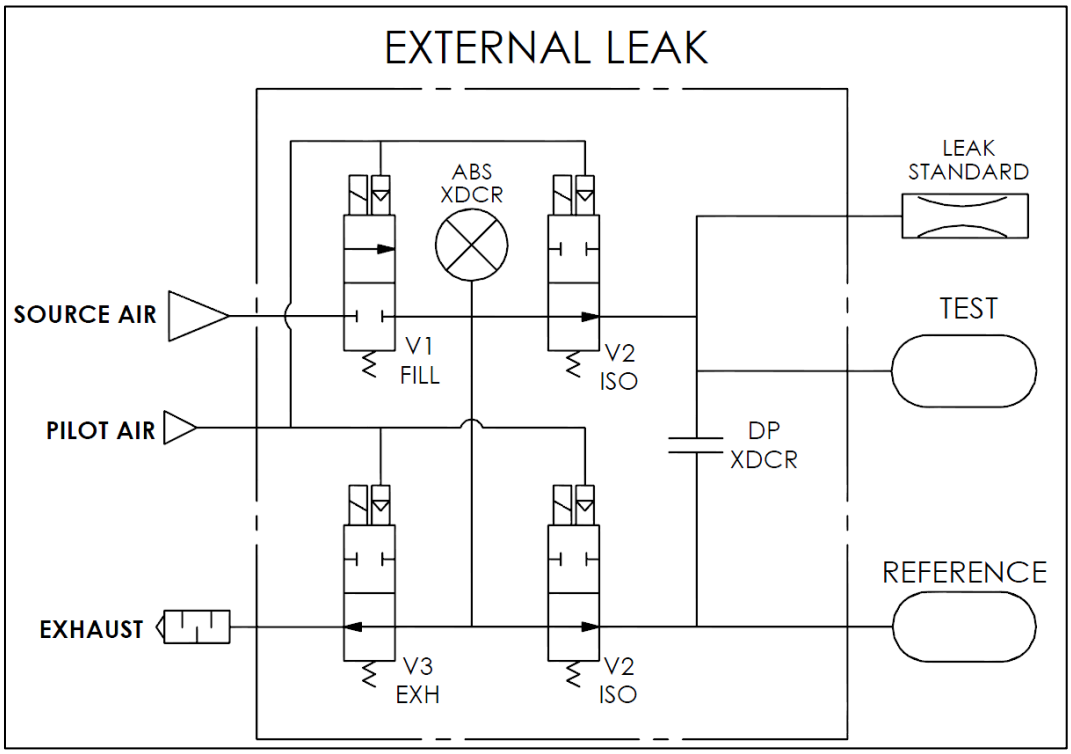
How it works

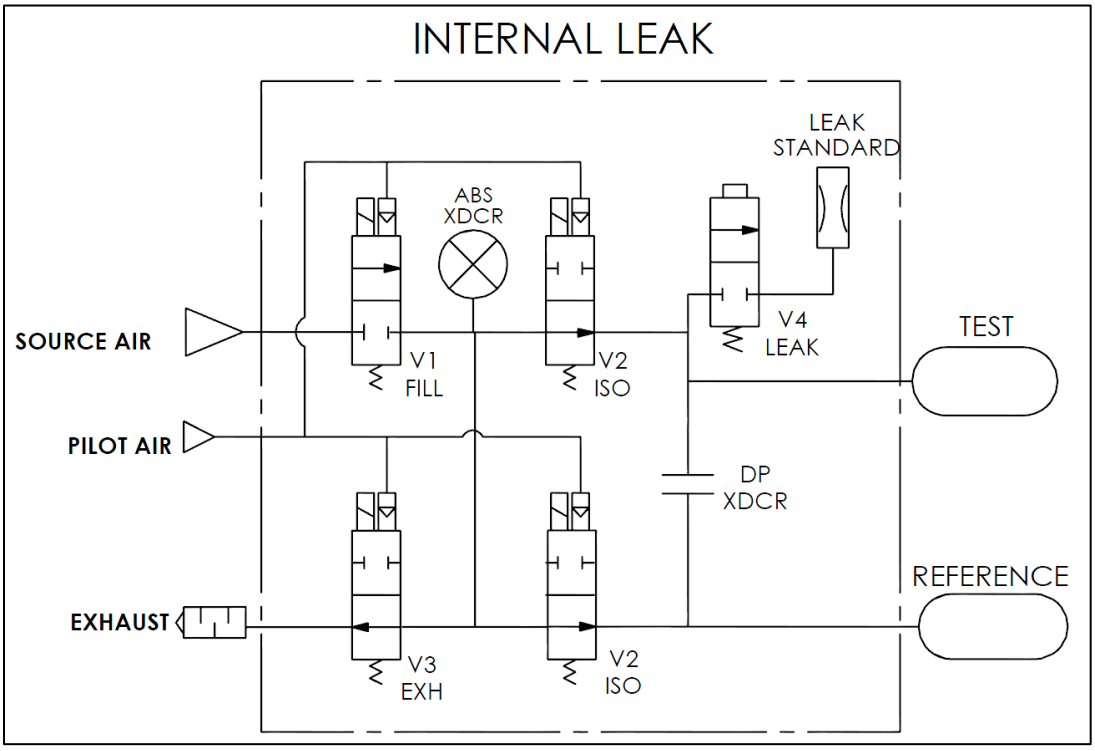
In order to detect leakage in a part, the change in pressure due to temperature and part elasticity must be allowed to settle before taking any pressure readings.

With differential pressure, a reference part volume (should be identical to the nominal test part volume) is pressurized simultaneously with the test part. A reference volume is not required, and the reference port may be capped when not used.

Leaks are determined by detecting the rate of pressure loss between the two parts. The instrument can be configured with an optional external leak standard port for easy introduction into the test circuit.

Leak Standard Pneumatic Diagrams





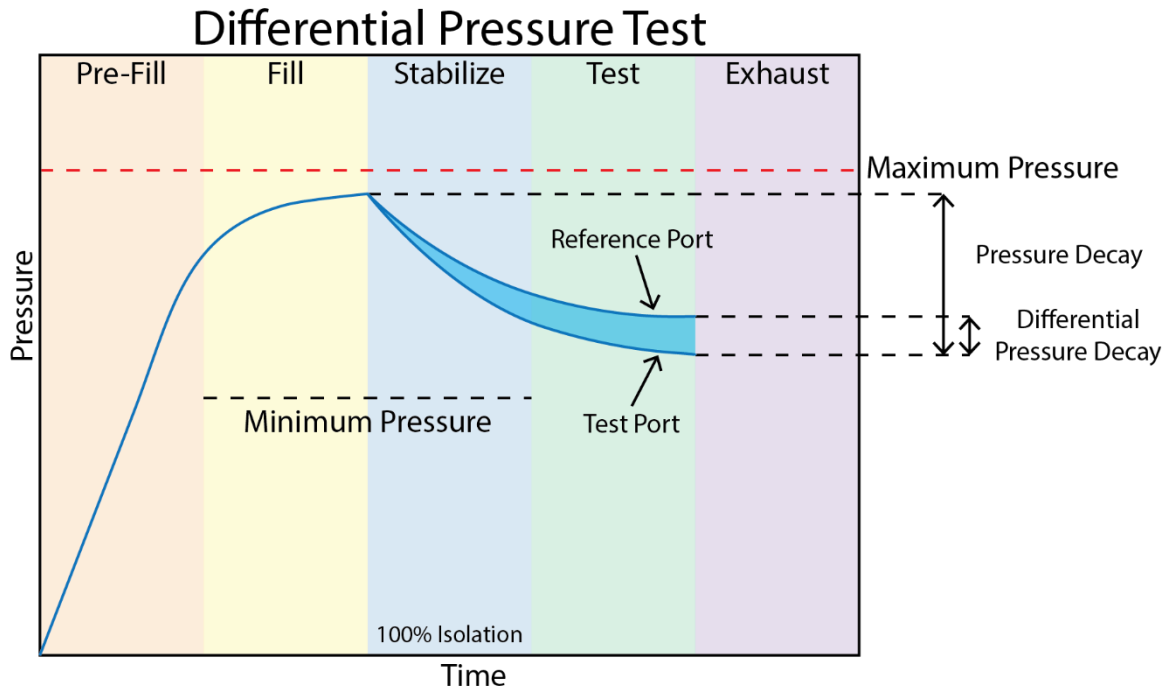
Test Setup

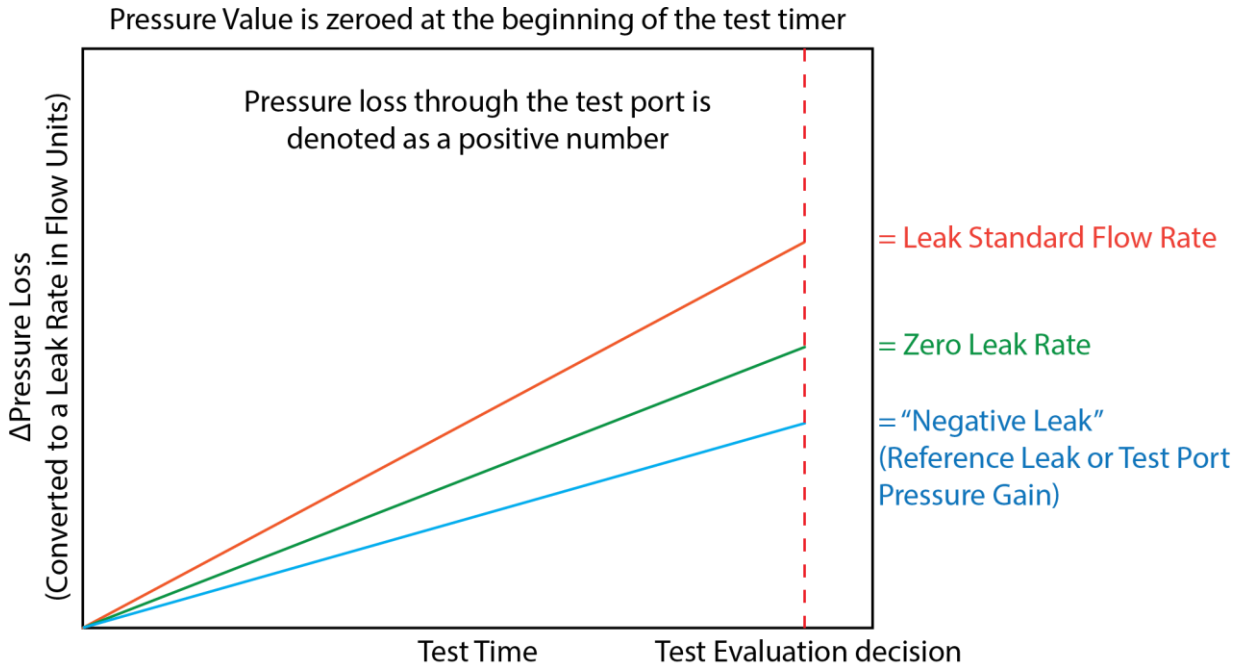
The test part and the reference volume are simultaneously pressurized to a preset pressure. The air in the system is then allowed to stabilize, with the supply valves all closed. After the stabilization time, the Differential Pressure Transducer is automatically zeroed.

During test, the pressure change in the test piece is compared to the pressure change in the reference volume, using the Differential Pressure Transducer. If the test piece is leaking, the difference will increase and be measured; an alarm limit may be set for a pass/fail decision

The charts in this chapter give an overview of the parameters used to set up a Pressure Differential Test and correlate the results to a flow rate using a leak standard. The Tables that follow give detailed descriptions of each parameter and also document the Display User Level associated with each parameter.

Note: To change the Display User Level, see Chapter 15 ***– Features***.


Differential Pressure Test
Pre-Fill
Fill
Stabilize
Test
Exhaust
Maximum Pressure
Reference Port
Pressure Decay
Differential
Pressure Decay
Pressure
Minimum Pressure
Test Port
100% Isolation
Time


Pressure Value is zeroed at the beginning of the test timer
Pressure loss through the test port is denoted as a positive number
ΔPressure Loss
(Converted to a Leak Rate in Flow Units)
= Leak Standard Flow Rate
= Zero Leak Rate
= "Negative Leak"
(Reference Leak or Test Port Pressure Gain)
Test Time
Test Evaluation decision

Timer Parameters

The Timers menu is located in the **Main Menu > Program Config > Timers** tab.

Timer	Description	User Display Mode
Tooling Extend 1	When tooling control is specified, there can be one extend timer for one tooling motion.	Basic Advanced, Admin
Prefill	Percentage of the fill timer where the minimum pressure limit is not monitored. This allows time within the fill stage for the instrument to achieve the minimum test pressure.	Advanced, Admin
Pre-Press	Time to enable part to reach the Pre-Pressure. *This parameter is only available if the Prefill Method selected is "Pre-Pressure Time"*	Basic Advanced, Admin
Charge	Time to enable part to reach the Charge Target Pressure. At the end of this timer, the instrument will read the pressure on the pressure transducer. *This parameter is only available if the Prefill Method selected is "Fixed Charge"*	Basic Advanced, Admin
Fill	Time to enable part to reach the Target Pressure. It may also be used as time to stabilize part pressure with additional air.	Basic Advanced, Admin
Isolation	Amount of stabilization time utilized to isolate the test part and reference volume prior to the test measurement.	Admin
Stabilize	Time to stabilize part pressure while isolated from the pressure regulator. This time directly affects the repeatability of the test.	Basic Advanced, Admin
Test	At the end of this timer, the instrument will read the pressure on the pressure transducer. This pressure is due to the backpressure created in the pneumatic circuit and part.	Basic Advanced, Admin
Exhaust	Time to relieve or vent part pressure before signaling the end of test. Need time to prevent blowing out debris or fixture seals.	Basic Advanced, Admin
Tooling Retract 1	When tooling control is specified, there can be up to five retract timers for up to five tooling motions. This is a not to exceed timer when feedback is being utilized.	Advanced, Admin
Relax	Timer used during Program Cal routine as a delay between calibration cycles to allow the master part to recover to repeatable virgin state. (Too short relax times result in decreasing pressure losses/flow results in successive tests.)	Basic Advanced, Admin

Pressure Parameters

The Pressure menu is located in the **Main Menu > Program Config > Pressure** tab.

Pressure	Description	User Display Mode
Pre-Pressure	Target Pre-Pressure. Used as a setpoint for the Electronic Regulator during the Pre-Pressure time. *This parameter is only available if the Prefill Method selected is "Pre-Pressure Time"*	Basic Advanced, Admin
Pre-Pressure Window	The percentage (plus and minus) about the Pre-Pressure value defining the minimum and maximum pressure at the end of the Pre-Pressure time. *This parameter is only available if the Prefill Method selected is "Pre-Pressure Time"*	Basic Advanced, Admin
Minimum Pressure	Minimum test pressure that must be met within the Pre-fill timer and maintained during the Fill and Stabilization timers. This is an early indication of a major leak	Basic Advanced, Admin
Target Pressure	Target test pressure. Also used as a setpoint for the Electronic Regulator.	Basic Advanced, Admin
Maximum Pressure	The value that must not be exceeded at any time to complete a successful test. If the pressure goes above the Maximum Test Pressure, the testing cycle (during Fill and Stabilization) will end as an Over Pressure Malfunction.	Basic Advanced, Admin
Charge Min Press	Minimum charge pressure that must be met within the Charge timer and maintained before the Fill timer. This is an early indication of a major leak. If the pressure is measured below the Charge Min Press at end of Charge segment, the testing cycle will end as a Below Charge Malfunction. *This parameter is only available if the Prefill Method selected is "Fixed Charge"*	Basic Advanced, Admin
Charge Target Press	Target Charge pressure. Also used as a setpoint for the Electronic Regulator in Charge segment. *This parameter is only available if the Prefill Method selected is "Fixed Charge"*	Basic Advanced, Admin
Charge Max Press	The value that must not be exceeded at end of Charge segment. If the pressure is measured above the Charge Max Press at end of Charge segment, the testing cycle will end as an Above Charge Malfunction. *This parameter is only available if the Prefill Method selected is "Fixed Charge"*	Basic Advanced, Admin

Test Parameters

The Test parameters menu is located in the **Main Menu > Program Config > TST: DPL** tab.

TST Parameter	Description	User Display Mode
Low Limit Leak	Lower set point value used to evaluate test results of parts.	Basic Advanced, Admin
High Limit Leak	Upper set point value used to evaluate test results of parts.	Basic Advanced, Admin
Decay Direction	Defines the method for calculating the part pressure decay during test: Loss – charged part decreasing pressure, Gain – part increasing pressure from external forces.	Basic Advanced, Admin
Min Mstr+Leak Loss	Minimum pressure loss allowable for the master part with Leak Standard during the calibration cycle. Use to prevent calibration to leaking master parts or fixtures.	Basic Advanced, Admin
Max Mstr+Leak Loss	Maximum pressure loss allowable for the master part with Leak Standard during the calibration cycle. Use to prevent calibration to leaking master parts or fixtures.	Basic Advanced, Admin
Min Leak Loss	Minimum pressure loss allowed that represents the pressure loss due to the Leak Standard used to calibrate the instrument.	Basic Advanced, Admin
Max Leak Loss	Maximum pressure loss allowed that represents the pressure loss due to the Leak Standard used to calibrate the instrument.	Basic Advanced, Admin
Min Master Loss	Minimum pressure loss allowable for the Master Part during the calibration cycle. Use to prevent calibration to the Self-Test cap.	Basic Advanced, Admin
Max Master Loss	Maximum pressure loss allowable for the Master Part during the calibration cycle. Use to prevent calibration to the Self-Test cap.	Basic Advanced, Admin
Min Perform Factor	Minimum acceptable value for the Performance Factor compared after the calibration cycle to prevent improper calibration.	Basic Advanced, Admin
EDC Enabled	When enabled, Environmental Drift Correction (EDC) monitors and continually corrects final Leak Rate calculations based on the moving average shift of test results within a band about the Master Part calibration curve.	Advanced, Admin
EDC Percentage	Percentage (Plus and Minus) band defined by a percentage of High Limit about the Master Part Curve. EDC continually accumulates and calculates an offset for the test results.	Advanced, Admin
EDC Quantity	Number of test results utilized in calculating the EDC factor.	Advanced, Admin

Program Calibration

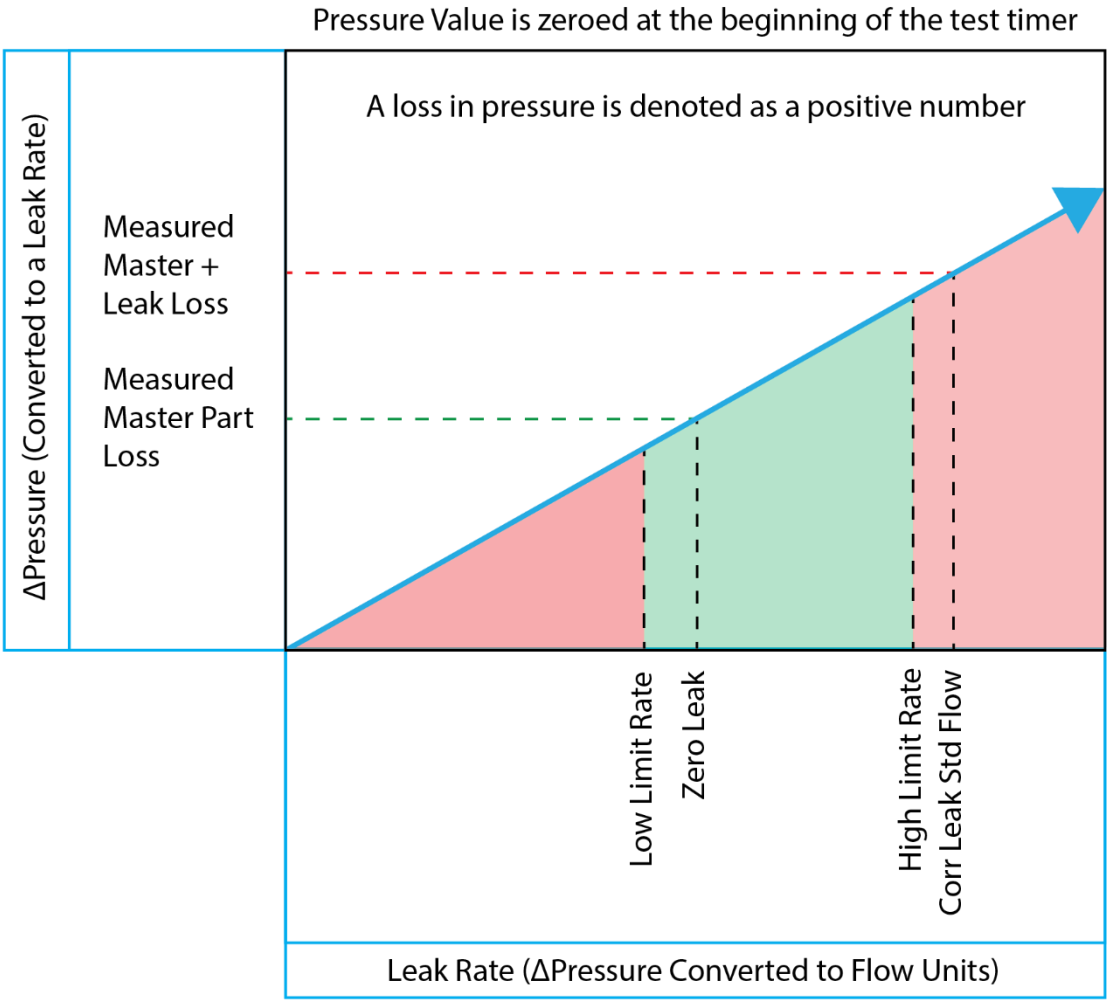
In order to convert the pressure loss measured by the instrument to a leak (flow) rate, the instrument uses a leak standard and needs to run the "Program Cal" routine. This procedure requires at least one known non-leaking part referred to as a "master part". This procedure tests a non-leaking master part connected to the instrument using the timers and pressures established for the program. The procedure automatically tests the non-leaking master part twice with the Relax timer delay between tests. Within each program that uses a leak standard, Program Cal can be configured to use one of four methods. See Setting the Cal Method and Leak Standard Location in Chapter 15 – Features.

Remember: The Leak/Cal menu has a parameter called Leak Std/Cal Define that determines the location for the leak standard settings.

When set to "Channel", leak standard settings are located in the Channel Config menu.

When set to "Program", leak standard settings are located in the Program menu.

Determine how you plan to use your leak test instrument. Review Setting the Leak Standard Values ***section on page 14. It is critical to make sure the leak standard values are set correctly for proper use. To view the Cal Method parameter, you must be in the Advanced or Admin Display User Level. To change the Display User Level, see*** Chapter 15 ***– Features.***


Pressure Value is zeroed at the beginning of the test timer
A loss in pressure is denoted as a positive number
ΔPressure (Converted to a Leak Rate)
Measured Master + Leak Loss
Measured Master Part Loss
Low Limit Rate
Zero Leak
High Limit Rate
Corr Leak Std Flow
Leak Rate (ΔPressure Converted to Flow Units)

Initiating the Program Cal Sequence

To initiate a Program Cal routine, go to **Main Menu > Program Cal** tab, select **OK** and press **Enter**. The Program Cal wizard will tell you to connect a non-leaking master part. Connect the non-leaking master part to the instrument. Push the Start button to initiate the Program Cal routine. The system will conduct an initial test of the non-leaking master part to measure the pressure loss associated with a non-leaking part. This represents the typical offset associated with testing parts within the environment of the test system. The pressure loss value is saved as the Master Part Loss. The system will conduct a second test on a non-leaking master part with a known calibrated leak standard included in the test. The pressure loss value result for this test is saved as the Master+Leak Loss.

Performance Factor

Upon the successful completion of the Program Cal routine, the display will show the calculated Performance Factor for the calibration. The Performance Factor is an estimate of the quality of the calibration. It combines the ratio of the Hi Limit Leak result to the non-leaking master part result, the test pressure, and difference between the Hi Lim result and the non-leaking master part result to scale its anticipated performance. This value ranges from 0 to 100. It is generally desirable to have a Performance Factor of 35 to 100. The actual acceptable Performance Factor can vary depending on the desired Gage R&R performance of the test. Here is the Performance Factor equation:

Performance Factor = **Cal Ratio** x **Pressure Loss Penalty** x **Time Penalty** x **100**

The pressure loss penalty is greater for smaller pressure loss values. The time penalty is greater for shorter Test cycle timer values. Generally, longer stabilize and test cycle timer settings will produce higher Performance Factors and improved Gage R&R performance.

Note: The instrument will require a Program Cal routine if any parameters that affect the calibration are modified.

Conditions for a Successful Calibration

Several conditions must be met during the Program Calibration routine for the instrument to accept and store the calibration results.
The conditions are based on the following measurements or calculations:

1. DP Master Part Loss
    a. Must be greater than the Min Master Loss limit
    b. Must be less than the Max Master Loss limit
    c. Must be less than the Master+Leak Loss measurement
2. DP Master+Leak Loss
    a. Must be greater than the Min Mstr+Leak Loss limit
    b. Must be less than the Max Mstr+Leak Loss limit
    c. Must be greater than the Master Loss measurement
3. DP Leak Loss
    a. Must be greater than the Min Leak Loss limit
    b. Must be less than the Max Leak Loss limit
4. Performance Factor
    a. Must be greater than the Min Perform Factor limit

If the Program Cal routine is successfully completed, "PROGRAM CALIBRATION PASSED" will be displayed. If there are any problems during the Program Cal sequence an error will be displayed. If there is an error, see Appendix A - Message and Error Codes.

Calibration Parameters

The Calibration parameters menu is located in the **Main Menu > Program Config > CAL: DPL** tab. These calibration parameters are values that are measured or calculated as a result of the Program Cal routine for a Differential Pressure Decay-Leak Std test.

CAL Parameter	Description	User Display Mode
Performance Factor	This is a Performance value generated by the actual calibration cycle to be compared to the Min Perform Factor input as a Test Parameter.	Basic Advanced, Admin
Master Part Press	Actual pressure data generated for the master part during the calibration cycle.	Advanced, Admin
Master+Leak Press	Actual pressure data generated for the master part with Leak Standard during the calibration cycle.	Basic Advanced, Admin
DP Master Part Loss	Differential pressure loss during the calibration cycle of the Master Part and stored to represent normal differential loss at the specified Target Pressure.	* Viewable in Basic & Advanced **Editable in Admin**
DP Master+Leak Loss	Differential pressure loss during the calibration cycle of the Master Part with Leak Standard and stored to represent normal loss + leak standard differential loss at the specified Target Pressure.	* Viewable in Basic & Advanced **Editable in Admin**
DP Leak Loss	Calculated differential pressure loss, based upon measured differential pressure losses during the Program Cal routine. Corresponds to the actual differential pressure loss related to the leak standard.	*Viewable in Basic & Advanced **Editable in Admin**
Master Part Loss	Pressure loss during the calibration cycle of the Master Part and stored to represent normal loss at the specified Target Pressure.	* Viewable in Basic & Advanced **Editable in Admin**
Master+Leak Loss	Pressure loss during the calibration cycle of the Master Part with Leak Standard and stored to represent normal loss + leak standard loss at the specified Target Pressure.	* Viewable in Basic & Advanced **Editable in Admin**
Leak Loss	Calculated pressure loss based upon measured pressure losses during the Program Cal routine. Corresponds to the actual pressure loss related to the leak standard.	*Viewable in Basic & Advanced **Editable in Admin**
Corr. Leak Std Flow	The calculated leak standard flow rate based on the Program Target Pressure, the leak standard calibrated pressure, and the leak standard calibrated flow rate.	Advanced, Admin

Note: * = These CAL parameters are for those customers who want to do CALS on a series of parts so they can manually input the ideal settings for these parameters to compare against.

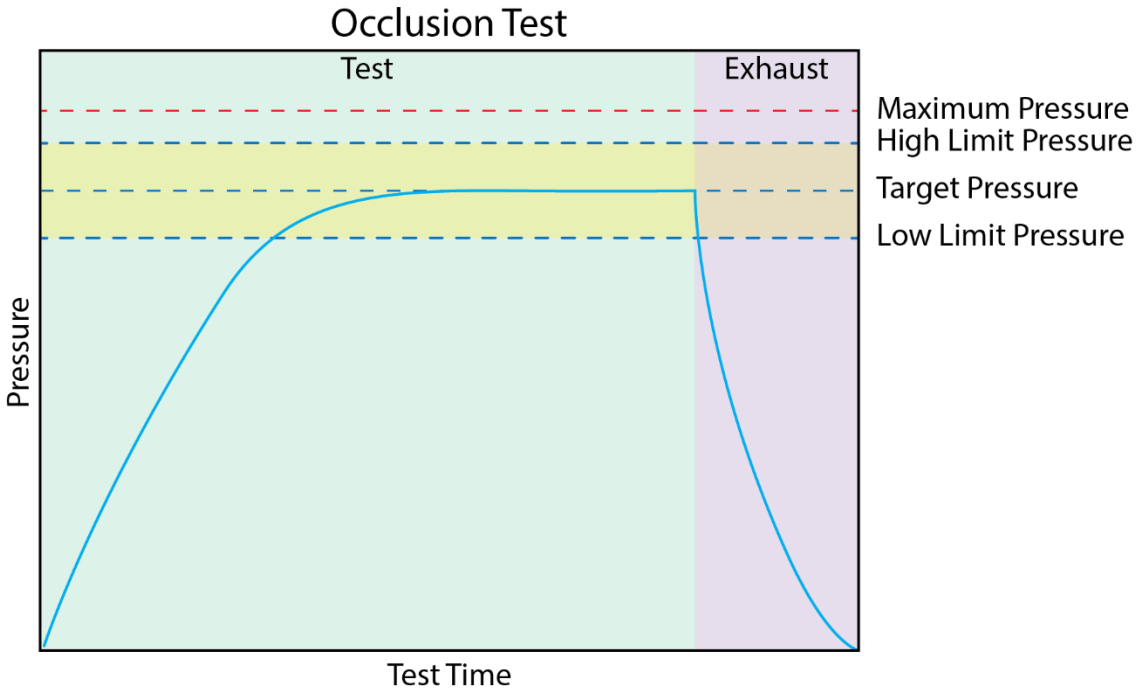
Chapter 8 – Occlusion

This chapter explains the theory and parameters for conducting an Occlusion Test. The result of this test is the measured back pressure at the expiration of the Test sequence.

The Occlusion Test uses back pressure to test the part. The part is pressurized throughout the test from a fixed pressure regulator setting. At the end of the Test timer the actual test pressure is compared to the Low Limit Pressure and High Limit Pressure settings. Low Limit Pressure indicates high flow or minimum blockage or low back pressure. High Limit Pressure indicates low flow or maximum blockage or high back pressure.

The Chart below give an overview of the parameters used to set up an Occlusion Test. The Tables that follow give detailed descriptions of each parameter and also document the Display User Level associated with each parameter.

Note: To change the Display User Level, see Chapter 15 ***– Features.***



Timer Parameters

The Timers menu is located in the **Main Menu > Program Config > Timers** tab.

Timer	Description	Display User Level
Tooling Extend	When tooling control is specified, there can be one extend timer for one tooling motion. This is a not to exceed timer when feedback is being utilized.	Advanced, Admin
Test	At the end of this timer, the instrument will read the pressure on the pressure transducer. This pressure is due to the backpressure created in the pneumatic circuit and part.	Basic Advanced, Admin
Exhaust	Time to relieve or vent part pressure before signaling the end of test. Need time to prevent blowing out debris or fixture seals.	Basic Advanced, Admin
Tooling Retract	When tooling control is specified, there can be one retract timer for one tooling motion. This is a not to exceed timer when feedback is being utilized.	Advanced, Admin

Pressure Parameters

The Pressure menu is located in the **Main Menu > Program Config > Pressure** tab.

Pressure	Description	Display User Level
Target Pressure	Target test pressure.	Basic Advanced, Admin
Maximum Pressure	The value that must not be exceeded at any time to complete a successful test. If the pressure goes above the Maximum Test Pressure, the testing cycle will end as an Over Pressure Malfunction.	Basic Advanced, Admin

Test Parameters

The Test parameters menu is located in the **Main Menu > Program Config > TST: OCC** tab.

TST Parameter	Description	Display User Level
Low Limit Pressure	Lower set point value used to evaluate test results.	Basic Advanced, Admin
High Limit Pressure	Upper set point value used to evaluate test results.	Basic Advanced, Admin
Test Evaluation	Test results are compared to two set points for pass or fail status. There are three areas for evaluation of results: above high limit, between limits, and below low limit. See Table below for codes.	Advanced, Admin

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Chapter 9 – Tooling Control

This chapter explains the tooling control capability of the instrument. Tooling control is a powerful feature that gives the instrument the ability to control cylinders and seal actuations.

> ***Note: The instrument must be in Advanced or Admin Display User Level to view and modify the tooling functionality. To change the Display User Level, see*** Chapter 15 ***– Features.***

The instrument includes user selectable digital inputs and outputs to increase the functionality and simplify the application to various test requirements. The tooling functions are defined within each program. This allows the flexibility to use different tooling functions; permitting the ability to seal unique ports for each program. The tooling functions are located in **Main Menu > Program Config > Tooling** tab.

It is important that all precautions be taken when using the tooling control functions of the instrument. If motions are being controlled, it is important to follow best engineering practices while designing the circuitry. This may include using safety modules in the circuit.

In order to implement the tooling functions, they must be interfaced with the inputs and outputs. See Chapter 10 - Inputs and Outputs.

Menus

Parameter	Description	Display User Level
Tooling Option	The options for this parameter are On, Off, and Disabled. On causes the tooling motion timers to appear on the Timers menu. When On, the instrument will perform these timers in the order they are listed. It will also allow the associated tooling outputs to appear in the selectable list in the Outputs menu. When Disabled, the tooling motion timers still appear but are ignored. It will also allow the associated tooling outputs to appear in the selectable list; however, the outputs are not active in this mode. When Off, the timers will not appear or be active.	Advanced, Admin
Number of Motions	This parameter defines the number of motions intended to be used. You can have 1 motion.	Advanced, Admin
Part Present Check	This parameter is not editable. It determines that the part present input is checked when the start input is received. This parameter is active only when one of the Inputs is set to "Part Present".	Advanced, Admin
Tooling Feedback 1	Sometimes it is desirable to use proximity sensors or pressure switches on cylinders or seals to determine if and when they reach their intended location. The instrument has the ability to monitor these actions using this parameter. This parameter may be set to "Extend", "Retract", or "Both" to determine which locations are to be monitored.	Advanced, Admin

Chapter 10 – Inputs and Outputs

This chapter explains the Input and Output (I/O) capabilities of the instrument. The I/O parameters are located in ***Main Menu > Program Config > HW Input*** *and* ***HW Output*** *tabs.*

> ***Note: The instrument must be in Advanced or Admin Display User Level to view and modify the Input and Output functionality. To change the Display User Level, see*** Chapter 15 ***– Features.***

The instrument includes user selectable digital inputs and outputs to increase the functionality and simplify the application to various test requirements. The inputs and outputs are divided into two groups – Universal and Program Specific. When a Universal input or output is assigned in a program, it is automatically assigned and available within all programs. When a Program Specific input or output is assigned in a program, that particular input or output is constrained to use only the inputs or outputs within the same Functional Group. When the input or output is set to "Constrained" in a program, it will not function within that program.

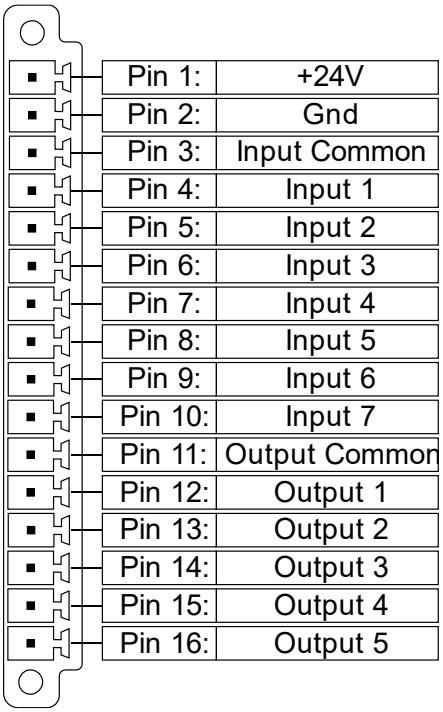
In order to remove the selection of an input or an output, change the parameter to either "Unassign" or "Unassign all Prog". Selecting "Unassign all Prog" will remove the selection of the input or output for all of the programs. Selecting "Unassign" will only remove the selection from the current program. "Unassign" is not available for Universal inputs or outputs.

Important Note: Any inductive loads connected to the instrument digital outputs must be properly suppressed, or undesirable instrument operation may occur. For inductive loads which do not have integration suppression circuitry, a flyback diode is recommend

Input and Output Wiring

The instrument comes equipped with 7 programmable inputs and 5 programmable outputs. Both inputs and outputs are 24VDC. For proper I/O operation, 24 VDC must be provided to the I/O connector. The instrument does not provide I/O power internally.

Input and Output Connector Pinout



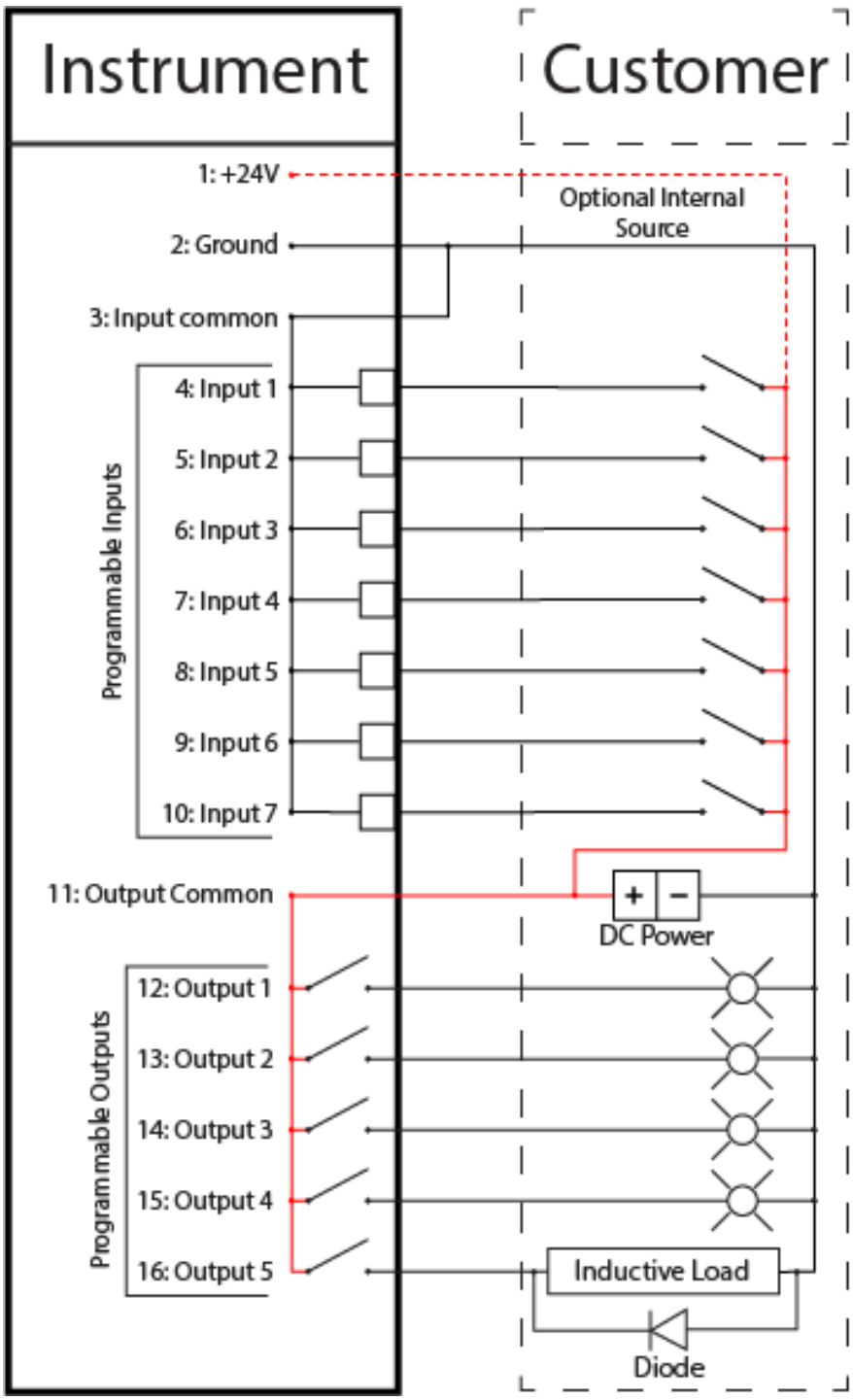
Digital Inputs 1-7 (24VDC NOMINAL)

Digital Outputs 1-5 (24VDC NOMINAL)
Maximum current draw for an individual output is 500 mA
Maximum current draw for all combined outputs are 1A
Fuse Specs can be found in the Sentinel MH Technical Specifications

User selectable or programmable outputs are listed in a table Programmable Inputs and Outputs Menus.

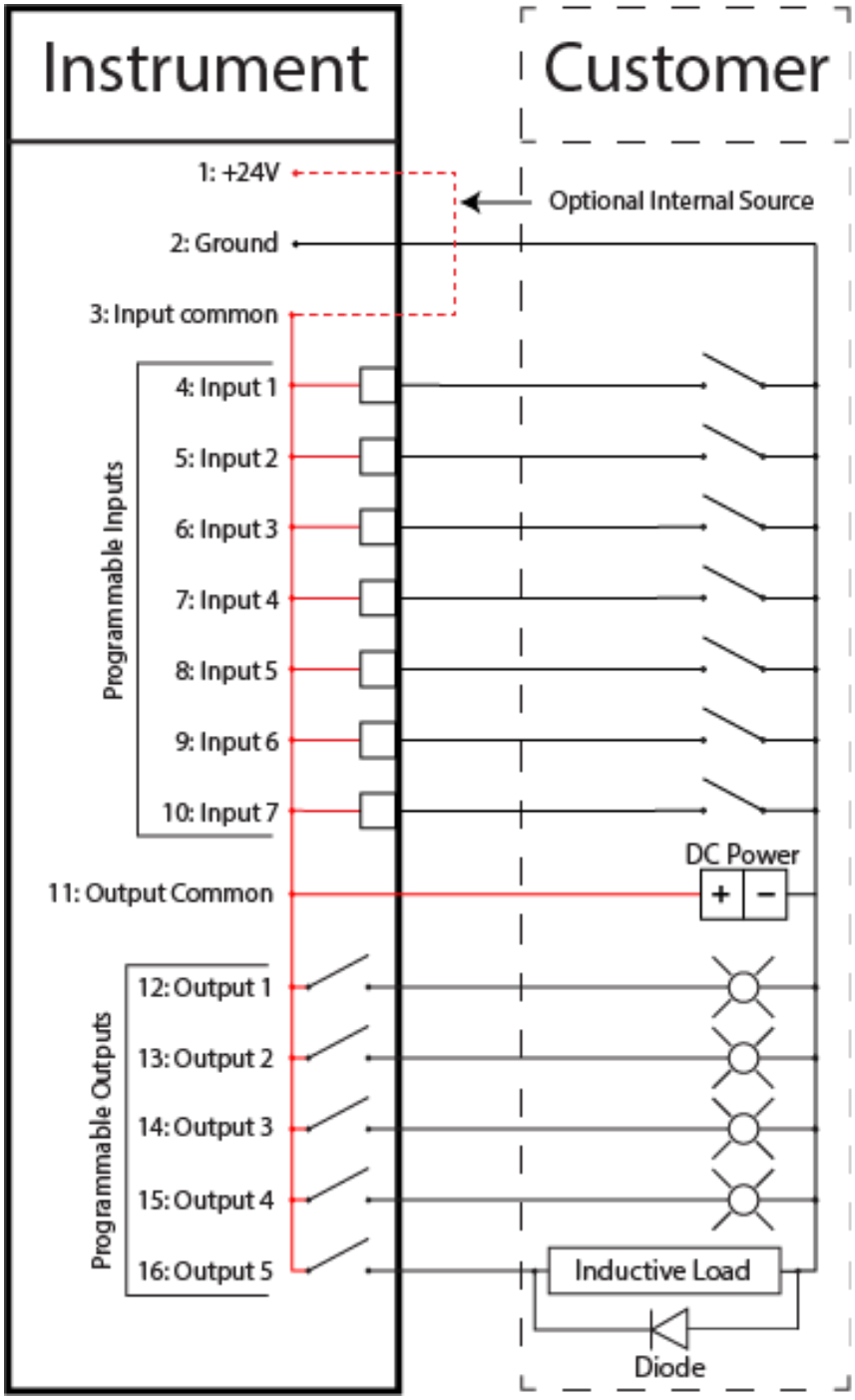
Typical Configuration – Sinking Inputs, Sourcing Outputs

Inputs run to ground and sink from powered inputs; outputs are connected to +24VDC and source power.



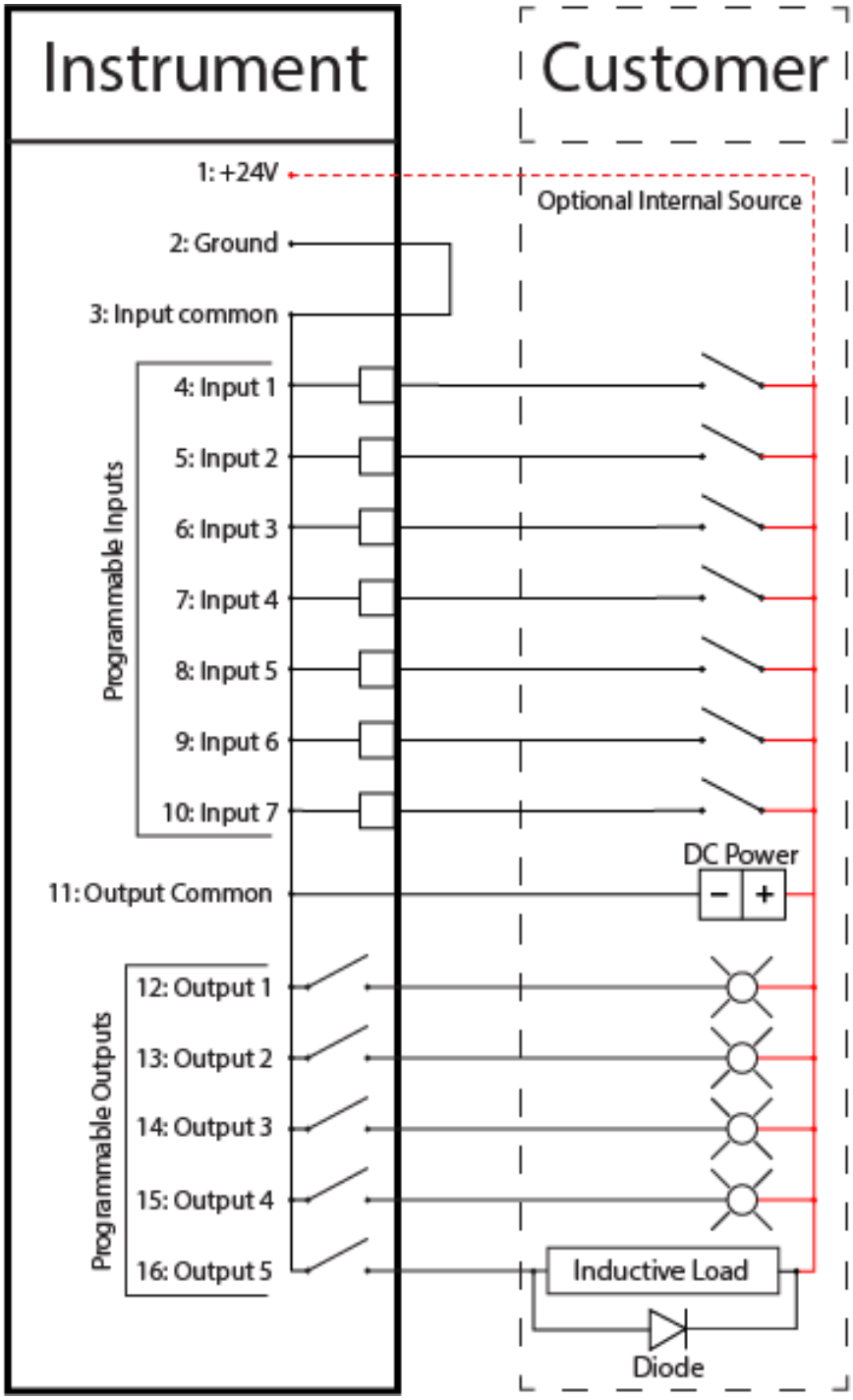
NPN Type – Sinking

The Instrument can be set to source +24VDC from both inputs and outputs and sink on the Customer side. This can be achieved through either internal power provided by the instrument, or external power using the input/output common pin to supply power.



PNP Type – Sourcing

The Instrument can be set to sink +24VDC from both inputs and outputs. This can be achieved through either internal power provided by the instrument, or external power using the input/output common pin to supply power.



Programmable Inputs and Outputs Menus

Input Options
Start Channel
Start Program
Stop/Reset
Hold
Vent/Halt
Program Cal
Open Leak Std
Part Present
SPC Test Part
Instrument Enable
Program Select B1
Program Select B2
Program Select B3
Program Select B4
Program Select B5
Program Select B6
Tool Ext Fdbk 1
Ext Press Sw
Tool Ret Fdbk 1
Unassigned

Output Options
Malfunction
Tool Extend 1
In Relax
Program Cal Mode
Program Cal Master
Program Cal Leak Std
Press Select
Prefill
In Fill
Fill Valve
In Stabilize
Isolation Valve
In Test
Test Passed
Test Failed
Bellow LL
Between Lim
Above HL
In Exhaust
Program Accept
Program Reject
Severe Leak
Tool Retract 1
Unassigned

Descriptions of these menu options are on the following pages in related groups.

Inputs for Program Control

Input	Description
Start Channel	Starts the active Program
Common	The Start Channel and Common inputs are universal inputs, where each part program can be set individually to use "Two Inputs to Start" or "Anti-Tie-Down" logic.
Vent/Halt	The Vent/Halt input safely ceases the operation of any tooling motion, removes all energy from the part by advancing through the exhaust segment and stops operation. Any programmed tooling motion required to return to the fully retracted positions must be initiated by the Stop/Reset input. While the Vent/Halt input is high, no additional test activity or tooling resets can occur. See description below.
Start Program	Changes the Current Program to the one assigned to this input and Starts the Program.
Stop/Reset	The Stop/Reset input is available to stop tests and retract tooling. When a stop/reset input is received the test cycle goes immediately through a Vent/Halt routine and then advances to retract the tooling. The Malfunction output (if programmed) will go high at the end of the last tooling motion for errors defined as malfunctions. See description below.
Hold	The Hold input halts or suspends the testing sequence as long as this input is high. This can be used to stop the testing while awaiting some other action to occur.
Part Present	Enabled by selecting Part Present as one of the inputs, the Part Present input must be high before a start test input is received. It also must go low between tests (after any tooling motion and before the start of the tooling motion for the next test). If more than one input is set to "Part Present", test will execute only if all inputs are made high.
Ex Press Sw	Enabled by selecting Ext Press Sw as one of the inputs, the External Pressure Switch input must go high before the end of the fill segment. This input is generally used to validate that the test part is properly charged by detecting pressure downstream of a potential blockage point. For Occlusion test type where fill segment is not present, Ext Press Sw input must go high before the end of the test segment. If Ext Press Sw input is not made high during test execution, then a malfunction occurs. For more than one input of Ext Press Sw, test will execute only if all inputs are made high before test segment of Occlusion test and fill segment for other test types.
Instrument Enable	Enabled by selecting Instrument Enable as one of the inputs, the Instrument Enable input must be high before a start test input is received. If the input doesn't go high before executing any test, it shows the malfunction message. If the input goes low in between test execution, then test aborts and shows malfunction message. For more than one input of Instrument Enable, test will execute only if all inputs are made high and test aborts with malfunction message if any one input is low or made low in between test execution.

Vent/Halt Request

The design of a Vent/Halt request (including initial phase of the Stop/Reset request) is to cease operation of tooling motions, safely remove all energy from the part, and stop operation.

A Vent/Halt request operation has multiple operations depending on the state of the instrument while testing. For better understanding, the test sequence can be broken into three basic groups: Tooling Extend, Part Testing, and Tooling Retract. The Program Evaluation (Accept Program/Reject Program/Malfunction/Severe Leak) is always after the Tooling Retract.
Other than a user generated Vent/Halt input, a number of test errors will generate a Vent/Halt request.

Vent/Halt – Instrument Idle
While the instrument is idle, a high Vent/Halt input will prevent the instrument from performing any test activity or tooling reset. Any type of Start or Stop request will be ignored until the Vent/Halt input is low.

Vent/Halt – Instrument execution during Tooling Extend Group
A Vent/Halt request will cause the output related to an executing Tooling Extend to be turned off. If the extend output is completed, it will remain in its current state. Since the part has not been charged no exhaust is necessary and execution will cease. A Tooling Reset is required.

Vent/Halt – Instrument execution during Part Testing Group
A Vent/Halt request will cause the instrument to exhaust any pressure within the part (if pressure was achieved) and execution will cease. Any output relating to Tooling Extend will remain in its current state. A Tooling Reset is required.

Vent/Halt – Instrument execution during Tooling Retract Group
A Vent/Halt request will cause the output relating to the current executing Tooling Retract to be turned off. Since the part has already been exhausted, execution will cease. A Tooling Reset is required.

Stop/Reset Request

The design of a Stop request is to safely remove all energy from the part, place the tooling into a fully retracted state, and stop operation. Depending on whether the instrument is actively testing or idle, the stop request has two modes of operations.

Stop – Instrument Testing

- If actively testing, a Stop request will cause the instrument to exhaust any pressure within the part (if pressure was achieved), and then execute a tooling reset sequence (only if tooling is enabled). The retract motion will be executed into a known retracted state for the next test.

Stop – Instrument Idle

- If the instrument is idle or in a safe state with the part pressure exhausted, a Stop request will cause the instrument to execute a tooling reset sequence (only if tooling is enabled). The retract motion will be executed into a known retracted state for the next test.

Besides a user generated Stop, a number of test errors will generate a Stop/Reset request that causes a Vent/Halt routine and continues with the tooling reset. The possible scenarios include: Transducer Malfunction (zero or over-range), External Switch Fault (not low or high at appropriate time), Severe Leak, Pressure Low/High, Calculation Faults, Calibration Errors, and General Program Fault (setup errors).

In addition, Stop/Reset input is required:

- After any tooling motion or test malfunction where the instrument completed Vent/Halt to safe state and stopped.
- Tooling must be reset to fully retracted position to start next test.

Inputs for Program Selection

<table>
<tr><th>Input</th><th colspan="2">Description</th></tr>
<tr><td rowspan="8">Binary Program Selection</td><td colspan="2">Programs can be remotely selected using the Binary Program Selection inputs or using one of the communication methods: RS232 or TCP/IP. The number of required inputs for Binary Program Selection depends on the highest program number of the program to which access is required.</td></tr>
<tr><td>Program Numbers</td><td>Binary Program Inputs</td></tr>
<tr><td>1</td><td>B1</td></tr>
<tr><td>2 – 3</td><td>B1 and B2</td></tr>
<tr><td>4 – 7</td><td>B1, B2, and B3</td></tr>
<tr><td>8 – 15</td><td>B1, B2, B3, and B4</td></tr>
<tr><td>16 – 31</td><td>B1, B2, B3, B4 and B5</td></tr>
<tr><td>32</td><td>B6</td></tr>
</table>

Note: The Program may also be remotely selected using Digital I/O (see Chapter 10), using Ethernet/IP™ (see Chapter 11), or using RS232 or TCP/IP Communication methods (see Chapter 12).

Inputs for Program Calibration

Input	Description
Program Cal	The Program Cal input prepares the instrument to perform a Program Cal routine. A Start input initiates the tooling motion and Program Cal routine.
Open Leak Std	The Open Leak Standard input will open the Leak Standard Calibration valve (if equipped) during the Fill, Stabilization, Test, and Exhaust segments. The valve will only open during the testing cycle when the input is high. If the input goes low during the testing cycle, the Leak Std Calibration valve will close. This input is generally used to automatically verify the calibration of a system by indexing or placing a good part in the test fixture and adding the External leak standard to measure a part with the leak rate equal to the External leak standard.
SPC Test Part	The SPC Test Part input identifies the next part to test as an SPC Part (often used when performing a test calibration verification test with a leak standard). This input must be high when receiving the Start input. This will mark the test results in the program result with an "*". Also, the test result output using the communication port will include the "*" to identify these parts for separate analysis.

Inputs for Tooling Motion

Input	Description
Tool Ext Fdbk 1	If enabled by selecting Tool Ext Fdbk 1 as one of the inputs, it is required that the Tool Extend Feedback input go high before the associated Tool Ext Timer expires. If the timer expires before the input goes high the instrument will issue a malfunction. A Stop/Reset will need to be initiated to reset the tooling.
Tool Ret Fdbk 1	If enabled by selecting Tool Ret Fdbk 1 as one of the inputs, it is required that the Tool Retract Feedback input go high before the associated Tool Ret Timer expires. If the timer expires before the input goes high the instrument will issue a malfunction. A Stop/Reset will need to be initiated to reset the tooling.

Outputs for Test Cycles

Output	Description
Press Select	Pressure Select goes high during the entire test sequence from start of Prefill or Fill segment to the end of Exhaust segment. This output can be used as a Test Active output.
Prefill	The Prefill output goes high during the Prefill portion of the Fill segment. This output is frequently used to control an external fast-fill valve when testing large volume parts. The external fast-fill valve opens until the instrument reaches the Minimum Pressure.
In Fill	The Fill segment output goes high during the Fill segment.
Fill Valve	This output mimics the Fill Valve functionality in the instrument. It goes high during the Prefill and Fill segments.
In Stabilize	The Stabilization segment output goes high during the Stabilization segment.
Isolation Valve	This output mimics the Isolation Valve functionality in the instrument. It goes high just prior to the fill valve closing and stays energized until the end of the Test segment.
In Test	The Test segment output goes high during the Test segment.
In Exhaust	The Exhaust segment output goes high during the Exhaust segment. This output is frequently used to open an external exhaust valve that vents the test air from the part through a larger valve for fast exhaust or to bypass the instrument and avoid polluting the instrument pneumatics with dirty part air.
In Relax	The relax timer output goes high during the Relax segment between the two tests of the Program Cal routine. It would go high at the end of the first test Exhaust segment until the start of the second test Prefill or Fill segment. The Relax segment is also functional between tests in the Auto Setup routine.

Outputs for Program Calibration

Output	Description
Program Cal Mode	The Program Cal Mode output goes high whenever the instrument is performing a Program Cal routine. It goes high at the beginning of the Prefill or Fill timer for the first test of the Program Cal routine. It stays high until the end of the Exhaust segment for the second test of the Program Cal routine.
Prog Cal Master	The Program Calibration Master output goes high during the first complete test of the Program Cal routine starting at the beginning of the Prefill or Fill segment to the end of the Exhaust segment. This output is used to alert an external process that the instrument is in the first test of calibration.
Prog Cal LS	The Program Calibration Leak Standard output goes high during the second complete test cycle of the Program Cal routine when the Leak Standard is added beginning with the Prefill or Fill segment to the end of the Exhaust segment. This output is used to alert an external process that the instrument is in the second test of calibration.

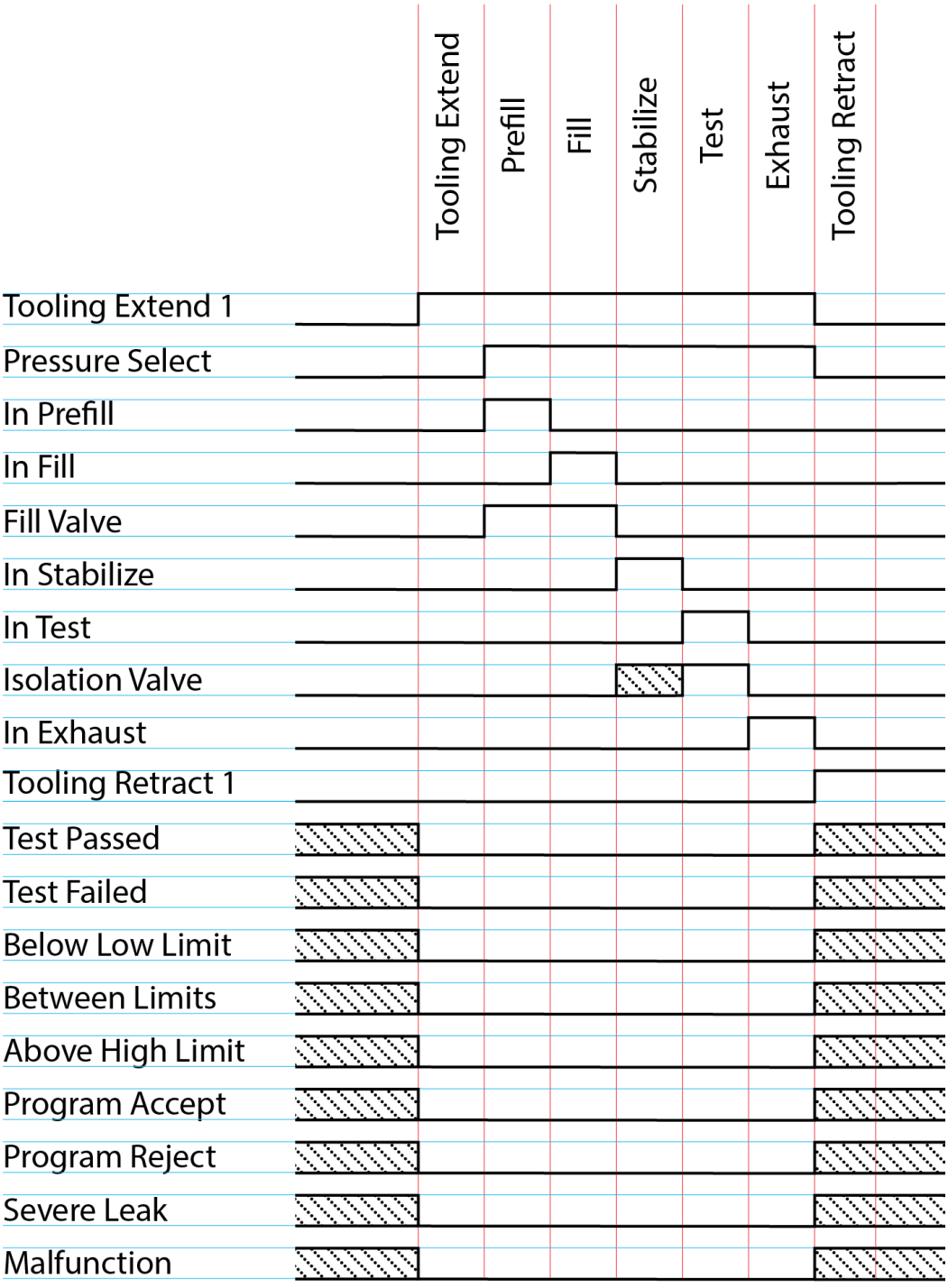
Outputs for Program Results and Test Results

Output	Description
Program Accept	The Program Accept output goes high at the completion of the tooling motion (if tooling is turned on) or at the completion of the Exhaust segment if the test passes.
Program Reject	The Program Reject output goes high at the completion of the tooling motion (if tooling is turned on) if the test fails. Program Rejects also include Severe Leaks when Minimum Pressure is not reached before reaching the Prefill set point or maintained during the Fill or Stabilization segments.
Malfunction	If a test has an error or disruption to the normal process and faults out of cycle before the normal completion, a malfunction will occur. With tooling control if the error or disruption occurs during initial tooling action, the tooling will retract. If the error or disruption occurs during the testing cycle, the test will advance immediately to exhaust and the tooling will retract automatically. The Malfunction output goes high at the end of the completion of the last tooling motion.
Severe Leak	If a test fails to reach Minimum Pressure before reaching the Prefill set point or fails to maintain at least the Minimum Pressure during the Fill and Stabilization segments, the instrument will exhaust the pressure in the part and output Severe Leak high.
Test Passed	Signals the completion of a test that passed at the start of the Exhaust segment. This output stays on until the start of a new test.
Test Failed	Signals the completion of a failed test at the start of the Exhaust segment. This output stays on until the start of a new test.
Below LL	Below Low Limit goes high at the start of Exhaust segment when test results are below the Low Limit set point and stays high until the start of the next test.
Between Lim	Between Limits goes high at the start of Exhaust segment when test results are between the Low Limit and High Limit set points and stays high until the start of the next test.
Above HL	Above High Limit goes high at the start of Exhaust segment when test results are above the High Limit set point and stays high until the start of the next test.

Outputs for Tooling Motion

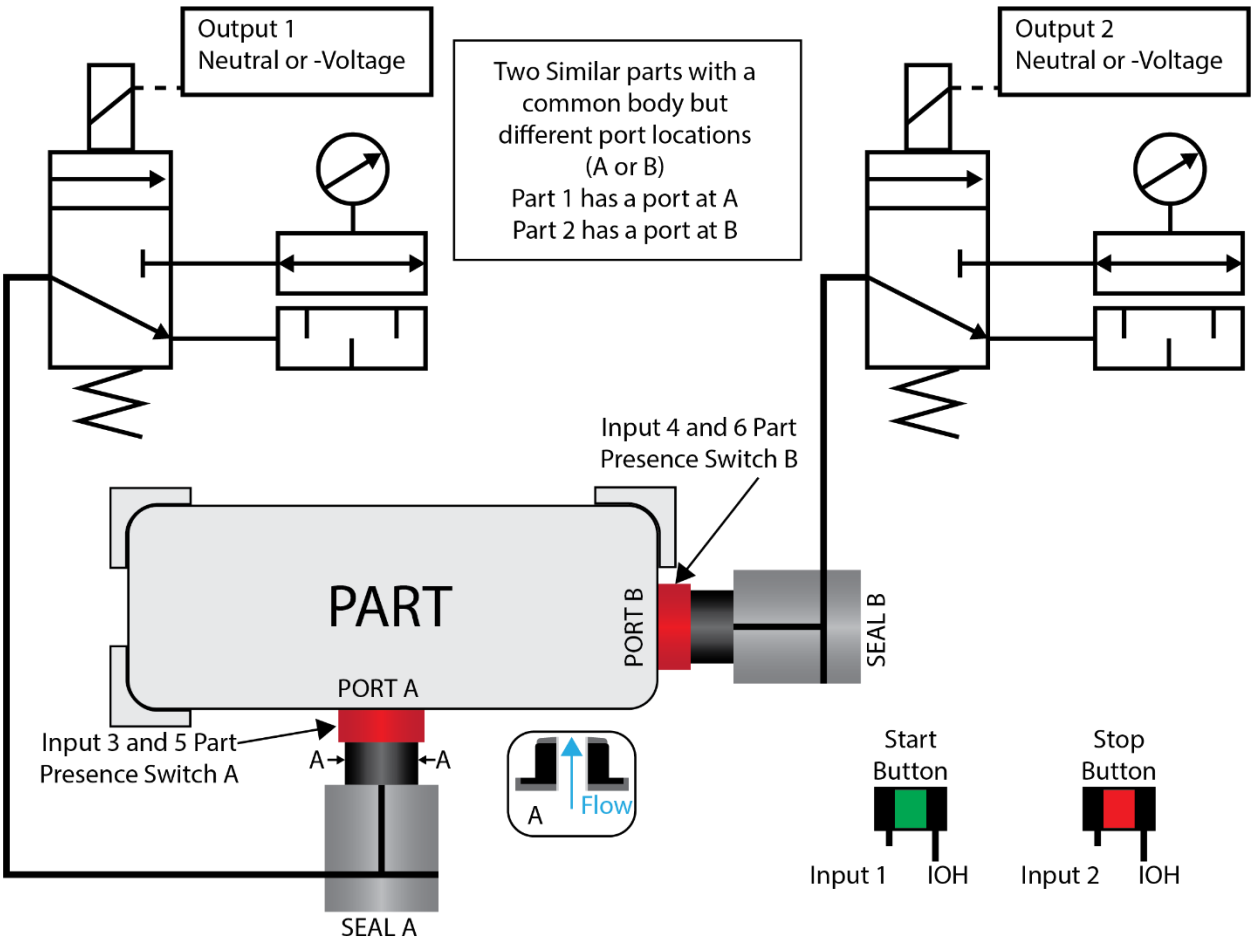
Output	Description
Tooling Extend 1	This output goes high during the Tooling Extend 1 segment. This option is only available if Tooling is set to "On" or "Disabled".
Tooling Retract 1	This output goes high during the Tooling Retract 1 segment. This option is only available if Tooling is set to "On" or "Disabled".

Timing Diagram



Tooling Example

The example below shows the power and flexibility of the Input and Output functionality. In this example, the inputs and outputs are being used to seal two different types of parts. The two different parts have sealing ports in different locations. The part presence sensors select the program in the instrument that controls the proper hardware based on the current part in the sealing nest.



Parameters	Program #1	Program #2
Tooling Motion	On	On
Number of Motions	1	1
Part Present Check	On Start	On Start
Retract on Reject	No	No

Input	Hardware	Program #1	Program #2
Input 1	Start Button	Start Channel	Start Channel
Input 2	Stop Button	Stop/Reset	Stop/Reset
Input 3	Part Select Switch	Program Select B1	Program Select B1
Input 4	Part Select Switch	Program Select B2	Program Select B2
Input 5	Part Presence Sensor A	Part Presence	Constrained
Input 6	Part Presence Sensor B	Constrained	Part Presence

Output	Hardware	Program #1	Program #2
Output 1	Seal A Extend	Tool Extend 1	Constrained
Output 2	Seal B Extend	Constrained	Tool Extend 1

Chapter 11 – EtherNet/IP

*This chapter explains the control capabilities of the MH using the **EtherNet/IP™** feature. The instrument is able to communicate over Ethernet via TELNET. **EtherNet/IP** is a registered trademark of ODVA, Inc.*

Instrument EtherNet/IP Functionality

EtherNet/IP is an industrial communication standard which encompasses the Common Industrial Protocol (CIP™) deployed over standard Ethernet technology (IEEE 802.3 with TCP/IP). While EtherNet/IP offers various optional topology methods, our implementation utilizes the conventional star with standard Ethernet infrastructure devices.

Features

EtherNet/IP provides the following capabilities:

- Standard set of I/O functionality for machine control
- Modify the current active Program
- User configurable soft I/O functions (16 input, 16 output)
- Test result summary data, and query of full result measurement information
- Latch feature for multi-device communications heartbeat monitoring

EtherNet/IP does **NOT** provide:

- Real-time test data streaming
- Access or modification of instrument settings:
  - Global configuration
  - Channel configuration
  - Program configuration

Compatibility

Provide full communication capabilities over EtherNet/IP™ with any Allen-Bradley ControlLogix® or CompactLogix PLC™.

Standard Fixed, Defined Inputs/Outputs

Enabling EtherNet/IP allows a set of fixed defined I/O points that are preconfigured are already part of EtherNet/IP structure. The following functionality is accessible by these predefined features.

- Start
- Stop
- Vent/Halt
- Reset
- Instrument Ready
- Result Ready
- Result Error
- Result Unique ID
- Program Accept
- Program Reject
- Malfunction
- Current Program Number
- Change Program Number
- Test Evaluation
- Timestamp
- Latch status

Setting EtherNet/IP User Defined Inputs and Outputs

The instrument comes equipped with 16 programmable inputs and 16 programmable outputs. The user can select up to 16 test or program specific I/O that are not in the Standard Fixed, Defined I/O set (described on the first page of this chapter). The following lists of input and output options are the same as the lists of hardware inputs and hardware outputs described in the Programmable I/O Table in the previous chapter titled Chapter 10 – Inputs and Outputs.

Input Options
Start Channel
Start Program
Stop/Reset
Hold
Vent/Halt
Program Cal
Open Leak Std
Part Present
SPC Test Part
Program Select B1
Program Select B2
Program Select B3
Program Select B4
Program Select B5
Program Select B6
Tool Ext Fdbk 1
Ext Press Sw
Tool Ret Fdbk 1
Unassigned

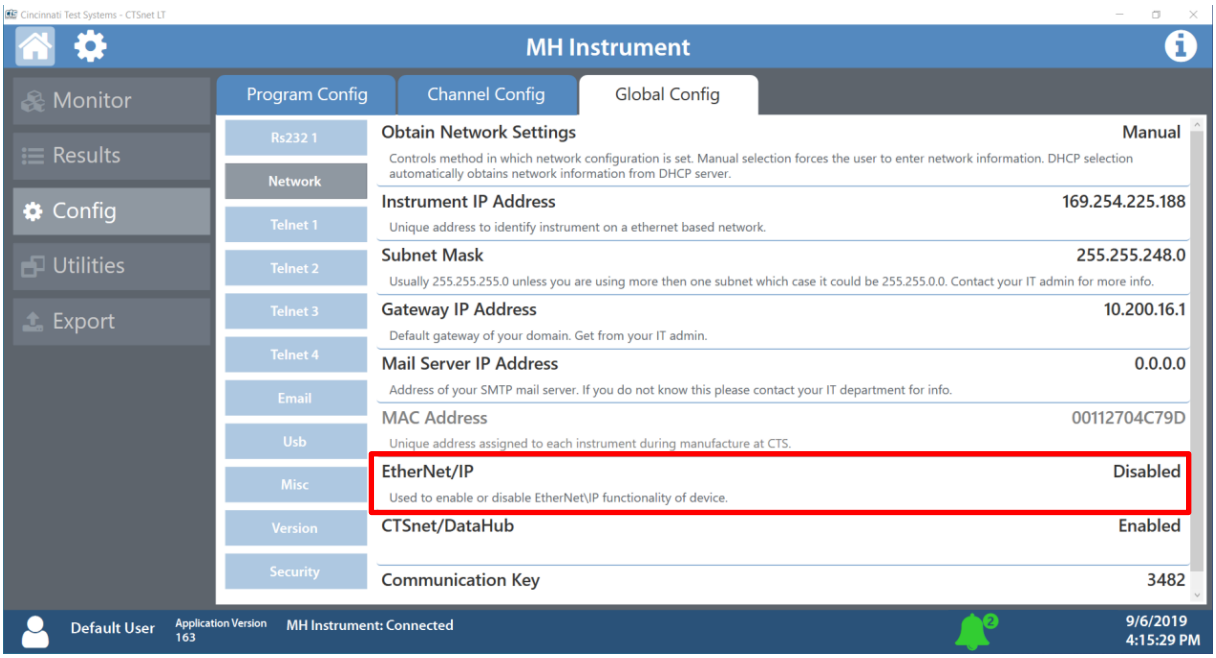
Output Options
Malfunction
Tool Extend 1
In Relax
Program Cal Mode
Program Cal Master
Program Cal Leak Std
Press Select
Prefill
In Fill
Fill Valve
In Stabilize
Isolation Valve
In Test
Test Passed
Test Failed
Bellow LL
Between Lim
Above HL
In Exhaust
Program Accept
Program Reject
Severe Leak
Tool Retract 1
Unassigned

Additional Reference Document

For more information on communicating with any Allen-Bradley ControlLogix or CompactLogix PLC, refer to the **EtherNet/IP AOI Integration Manual**. This document file will be located on the USB flash drive that was provided with the CTS instrument. If you cannot locate this file on the USB drive, it can be emailed to you. Contact the Cincinnati Test Systems Service department. See the final page of this manual for contact information.

Establishing EtherNet/IP Communication

The communication parameters are located in the **Config > Global Config > Network** tab menu. The first step in establishing communication with a PLC is to set **EtherNet/IP** to "Enable".



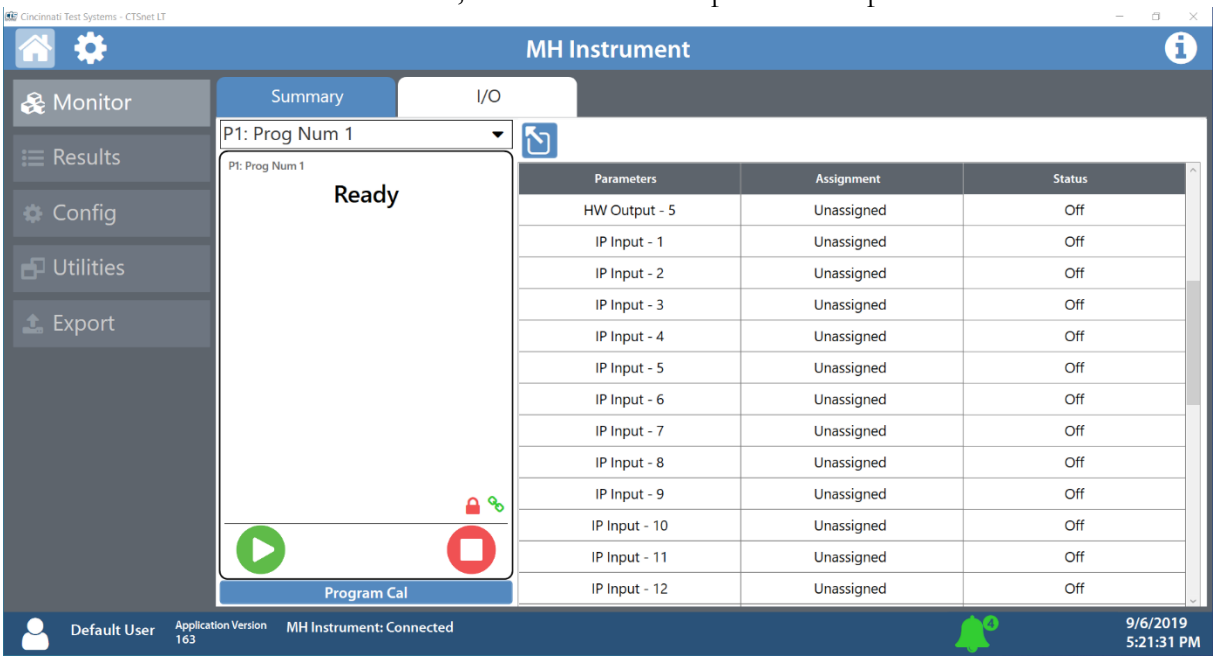
CAUTION: When changing the EtherNet/IP setting from "Enabled" to "Disabled", all the user assigned IP Inputs and IP Outputs become Unassigned. This is necessary because when EtherNet/IP is no longer functional, any I/O that may cause program faults must be removed. This includes Part Present, External Pressure Switch, etc. This means that all the user assigned IP Inputs and IP Outputs must be set up again.

Additional Menus

Turning on this feature will make 2 additional menu tabs visible on the Monitor menu screens and 2 additional menu tabs visible on the Program Config menu screen.

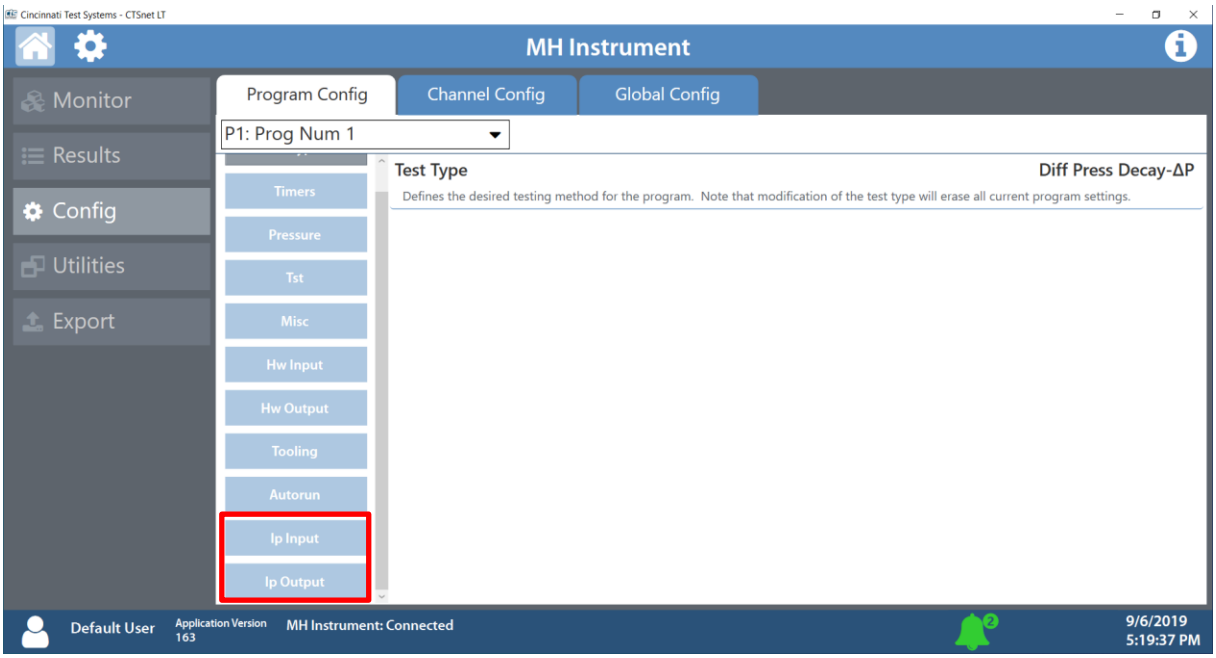
EtherNet/IP Monitor Screens

The IO menu under the monitor tab, there are now IP inputs and outputs as well as hardware.



EtherNet/IP Inputs and Outputs

Where there were 2 Program Config menu tabs for hardware inputs and outputs, now there will be 2 additional menu tabs where the EtherNet/IP inputs and outputs can be set.

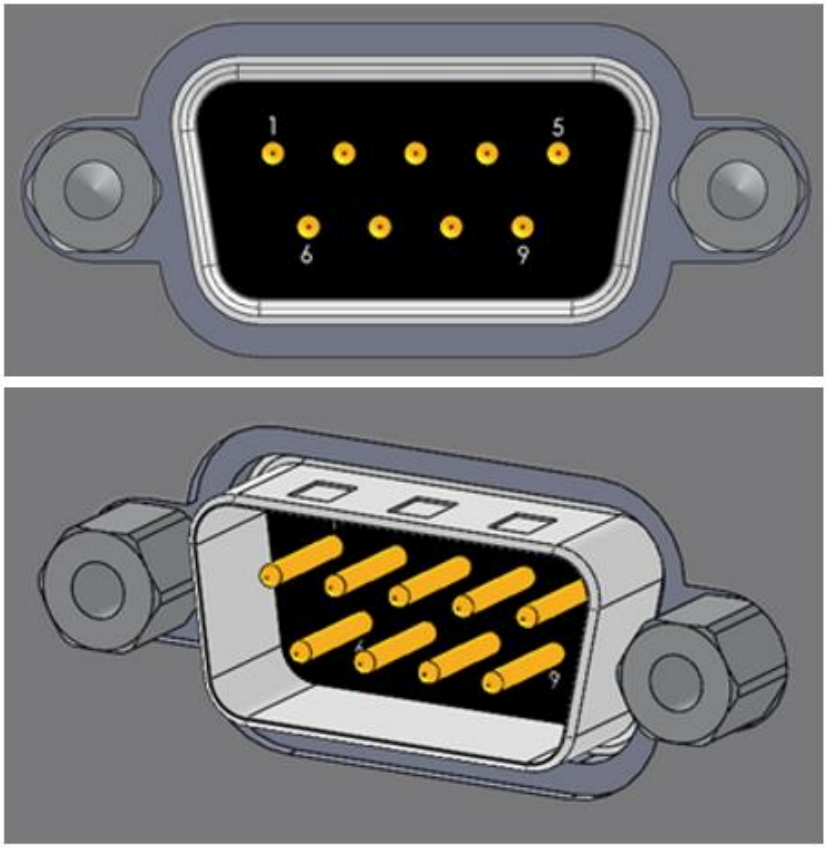


Chapter 12 – Communication

The instrument is able to communicate over RS232 and/or Ethernet via TELNET. This chapter explains how to setup communication with the instrument and how to decode the test results output.

RS232 Connector Pinout

The pinout for the RS232 connector, located on the front of the MH, is denoted in the diagram below. Pins 1, 4, and 6 are internally connected, but are unused by the instrument.



1	DCD
2	RX
3	TX
4	DTR
5	Ground
6	DSR
7	RTS
8	CTS
9	Not Connected

Establishing RS232 Communication

The RS232 parameters are located in **Main Menu > Global Config > RS232 1.** The first step in establishing RS232 communication with the instrument is to set the RS232 1 Interface parameter to "2-way" communication. Next, set the Baud parameter to match the baud rate of the device that will be communicating with the instrument. The options are: 115200, 57600, 38400, 19200, or 9600 bits per second.

> ***Note: The instrument always uses 8 data bits. The Parity is set to "None". The instrument uses 1 stop bit. The flow control is always set to "None".***

Once you have established communication with the desired device you may select whether you want the instrument to "echo" back each character it receives on the RS232communication port. This setting is located in the **Main Menu > Global Config > RS232 1** tab > **RS232 1 Echo**. If the parameter is set to "ON", the instrument will output an echo for each character it receives. If this parameter is set to "OFF", the instrument will not echo anything.

Establishing Ethernet (TCP/IP) Communication via TELNET

It is highly recommended that you consult with your company's IT department regarding the configuration of placing the instrument on any network. You should get the proper settings for the following parameters from your company's IT department.

The TCP/IP parameters are located in **Main Menu > Global Config > TCP/IP**. The first step in establishing Ethernet communication with the instrument is to set the Obtain Network Settings parameter to DHCP or Manual (static IP address). If set to "DHCP", the Instrument IP Address becomes a read only parameter. If set to "Manual", then you will need to set the Instrument IP Address manually. You may choose to let the instrument initially get its settings with DHCP and then change the setting to Manual to edit the IP Address of the instrument or lock it so that it will not change.

The Mail Server IP Address parameter should be set to the address of the SMTP mail server.

The Subnet Mask parameter will need to be configured next. The most common configuration for this parameter is "255.255.255.0" unless there is more than one subnet in which case a common configuration is "255.255.0.0".

The Gateway IP Address is the default gateway of the network domain.

The MAC Address is the hardware address of the instrument. This number is read-only.

Once you have established communication with the desired device you may select whether you want the instrument to "echo" back each character it receives on the TCP/IP 1 communication port. This setting is located in the **Main Menu > Global Config > Telnet 1** tab. Select **Telnet 1 Echo**.
If the parameter is set to "ON", the instrument will output an echo for each character it receives.
If this parameter is set to "OFF", the instrument will not echo anything.

Understanding the Header Information

All of the information that the instrument sends over the communication ports is preempted by header information. This data is sent to help parse specific information. This header information is in the format XXYYZZZ H. The header is followed by a Tab as shown in the table below:

Header	Description
XX	8-Bit CRC in HEX. Used for error checking.
YY	Sequence Code in HEX. The value increments from 01 to FF. This value can be used as a verification that all data has been received and nothing was missed by the receiving device.
ZZZ	Data length in HEX.
	Tab
H	Data Type Code. See Data Type Code Table
	Tab

Note: For the most up to date Data Type Codes, type "TABLE HEADER" into the instrument using the communication port. The instrument will return a list of about 8 Data Type Codes and descriptions. The table below is an example of the instrument response.

Data Type Code	Description
V	Variable Edit
L	List
M	Message
Q	Result List
T	Streaming Started
S	Streaming Value
X	Streaming Stopped
R	Result

Test Results via RS232 or Ethernet (TCP/IP) communication

Depending on which type of communication is being used, these settings are located in:

Main Menu > Global Config > RS232 1 tab > **RS232 1 Results**, or
Main Menu > Global Config > Telnet 1 tab > **TCP/IP 1 Results**.

In order for the instrument to send the test Result Data automatically once the test is complete the parameter is set to "ON". Once this parameter is turned on, the Result Field data parameters show on the screen. Each parameter may be turned on or off depending on the information that is required for to accompany each result. The Test Field parameter may be set to "All Result Information" or "First 2 Test Results". The "First 2 Test Results" will send the two primary results. The table below shows the format of the Test Result Data.

Parameter	Number of Characters	Format	Example Text	Description of Example
Channel #	4	C##	C01	Channel 1
Port #	3	N#	N1	Port 1
Program #	4	P##	P01	Program 1
Link Information	4		R--	No Link
Time	13	HH:MM:SS.XXX	16:15:14.123	16 hrs, 15 mins, 14.123 secs
Date	9	MM/DD/YY	40179	02/01/16
Unique Id	11	##########	0000098353	Unique test number
Program Evaluation	3	#	A	Accept
SPC Flag	2	#	*	SPC Test Data Result
Test Field	**First 2 Test Results**			
Test Type	8	###	DPL	Pressure Decay-Leak Std
Test Evaluation	2	#	P	Pass
Test Data 1	22	TDI Data Unit	LR 0.123456 sccm	Test Data Identifier - Value - Unit
Test Data 2	22	TDI Data Unit	LR 0.123456 sccm	Test Data Identifier - Value - Unit
TAB				Tab
TAB				Tab
CR				Carriage Return
LF				Line Feed

Test Field	All Result Information			
Test Type	8	###	DPL	Pressure Decay-Leak Std
Test Evaluation	2	#	P	Pass
Test Data 1	22	TDI Value Unit	LR 0.123456 sccm	Test Data Identifier - Value - Unit
Test Data 2	22	TDI Value Unit	LR 0.123456 sccm	Test Data Identifier - Value - Unit
|	|	|	|	|
Test Data X	22	TDI Value Unit	LR 0.123456 sccm	Test Data Identifier - Value - Unit
TAB				Tab
TAB				Tab
CR				Carriage Return
LF				Line Feed

Note: For the most up to date Test Data Identifier Codes, type "TABLE VARIABLE" into the instrument using the communication port. The instrument will return a list of about 550 Test Data Identifier Codes and descriptions. See the full list in Appendix E.

Note: For the most up to date Test Evaluation Codes, type "TABLE EVALUATION" into the instrument using the communication port. The instrument will return a list of about 120 Test Evaluation Codes and descriptions. See the full list in Appendix E.

Note: For the most up to date Program Evaluation Codes, type "TABLE RESULT" into the instrument using the communication port. The instrument will return a list of about 12 Data Program Evaluation Codes and descriptions. See the full list in Appendix E.

Streaming Measured Data

The instrument has the ability to stream measured data using either the RS232 or TCP/IP communication port (one or the other, not both simultaneously) in real time while the test is being conducted. This data may be collected and used for analysis. The data is comma delimited. The table below shows the format of the streaming data.

Parameter		Format	Example Text	Description of Example
Channel #	Comma Delimited	C##	C01	Channel 1
Program #	Comma Delimited	P##	P01	Program 1
Segment	Comma Delimited	XXX	PRF	Prefill Segment
Test Data	Comma Delimited	TDI Value Unit	LR 0.123456 sccm	Test Data Identifier - Value - Unit
TAB				Tab
TAB				Tab
CR				Carriage Return
LF				Line Feed

Note: For the most up to date Segment Codes, type "TABLE SEGMENT" into the instrument using the communication port. The instrument will return a list of about 120 Segment Codes and descriptions. See the full list in Appendix E***.***

Note: For the most up to date Test Data Identifier Codes, type "TABLE VARIABLE" into the instrument using the communication port. The instrument will return a list of about 550 Test Data Identifier Codes and descriptions. See the full list in Appendix E***.***

Parsing Data Packets

For users who are trying to parse data packets from the instrument, any line beginning with an asterisk "*" should be parsed to be ignored, as these lines will not have header information to be parsed. An example of these types of lines would be the Root menu displayed at instrument boot.

Reports

The instrument is capable of generating a variety of reports through RS232, Ethernet, or Email. The reports available are in the table below.

Report	Description
Cur Program Res	Reports all of the test results for the current active program. The current program can be seen in the bottom right hand corner of the display.
All Results	Reports all of the test results in the instrument memory.
Chan Last 1000	Reports the last 1000 test results.
Chan Last 100	Reports the last 100 test results.
Chan Last 20	Reports the last 20 test results.
Chan Last Res	Reports the last test result.
Global Config	Reports all of the parameters and their settings within the Global Config menu.
Channel Config	Reports all of the parameters and their settings within the Channel Config menu.
Cur Program Config	Reports all of the parameters and their settings within the current active program. The current program can be seen in the bottom right hand corner of the display.
Program Config	Reports all of the parameters and their settings within the Program Config menu.
Regulator Cal	Reports the Electronic Regulator Calibration data if the instrument is configured with an electronic regulator.
Transducer Ver	Reports the Transducer Verification data of the last Transducer Verification conducted on the instrument.
Transducer Cal	Reports the Transducer Calibration data of the last Transducer Calibration conducted on the instrument.
Channel Cntrs	Reports all of the counters in the instrument.

CTS DataHub

The CTS DataHub interface is a custom interface designed to work with a QualityWorX CTS Datahub setup. When **CTS DataHub** is enabled, the QualityWorX CTS Datahub setup will be able to communicate with the MH instrument to capture streaming and result data. This data is stored on the QualityWorX CTS Datahub setup and allows for engineers and technicians to analyze and report on a collection of data from your production line.

The CTS DataHub parameter is located in **Main Menu > Global Config > Network**. When CTS DataHub is enabled, a new parameter **Configuration Key** will appear. This parameter is currently unused.

To setup QualityWorx CTS Datahub, please refer to the QualityWorX CTS Datahub Getting Started guide.

Chapter 13 – Webserver

The instrument provides a web server to control and configure the instrument. The Web Server can be used to display and update configuration, backup/restore instrument configurations, upgrade instrument firmware, and navigate remotely.

CTSnet LT is the recommended application for instrument configuration and control. Optionally the onboard webserver can be used in situations where CTSnet LT cannot be installed, and only a web browser is available.

System Requirements

To use the Web Server, you must have the following:

- a TCP/IP-based network
- a web browser installed on your computer, preferably either Google Chrome 60.0X or Microsoft Internet Explorer 11.0X and above

Note: The web server can be accessed from any operating system that supports the TCP/IP protocol and a web browser. You cannot view the embedded web server pages from outside a firewall.

Viewing the Web Server

Launch your web browser. In the Address or Go to field, type the IP address assigned to the instrument (for example: http://192.168.1.1). For more details on setting up the IP address on the instrument, refer to Chapter 12 - Communication.

Home Page

The top section will always display the Identity information (Instrument name, Firmware Version, Serial number, and MAC address) of the instrument. The Home page is shown in Figure 1.

Figure 1 Web page - Login Page

Web Server Login

Once you click **Login**, the web server will prompt you for a Username and Password. You must login with the appropriate username and password to access the webserver features. For more details on security, please refer to Chapter 14 - Security.

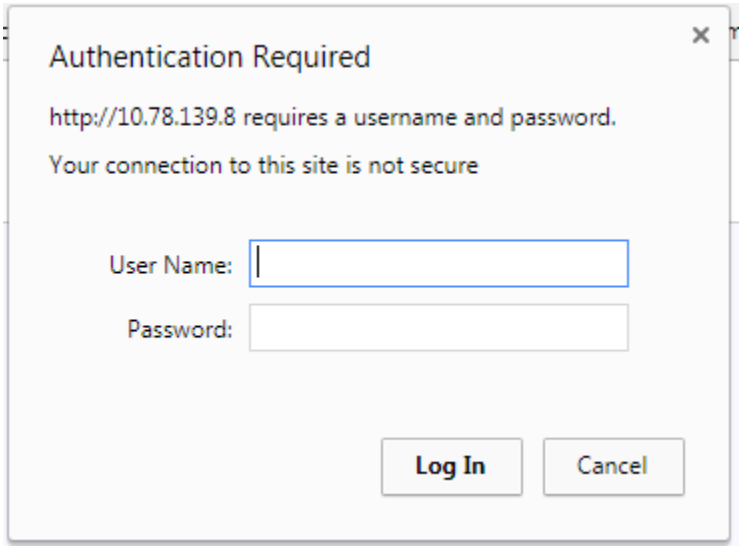


Figure 2 Security login

Navigation - Web Server

The left section lists all available menus. Clicking a menu in the left section will update the right section with content for the selected menu.

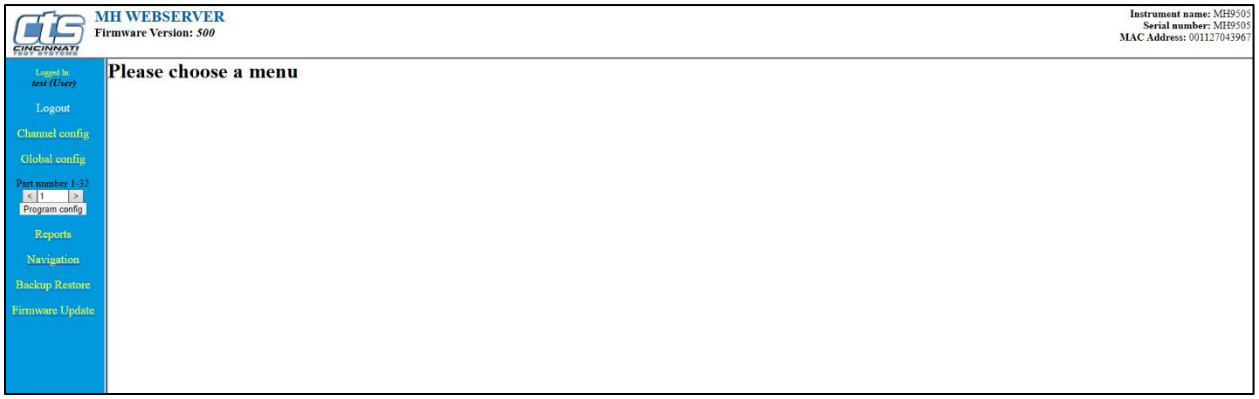


Figure 3 Web Page - Main Page

The **Channel config** page allows you to configure Channel Config parameters for the instrument.

Figure 4 Web Page - Channel Config

The **Global config** page allows you to configure Global Config parameters for the instrument.

Figure 5 Web Page - Global Config

The **Program config** page allows you to configure Program Config parameters for the selected program. Use the arrow keys to select the desired program number.

Figure 6 Web Page - Program Config

The **Reports** page allows you to generate a variety of Reports for the instrument.

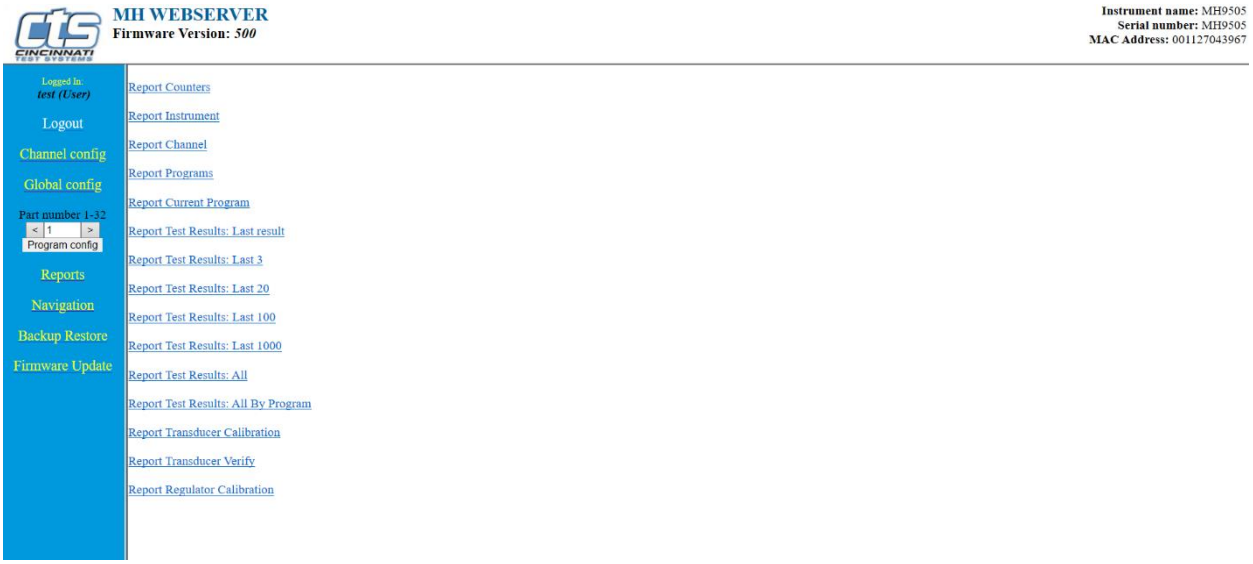


Figure 7 Web Page - Reports

The **Navigation** page gives you a similar user interface to the one available on the front display of the instrument.

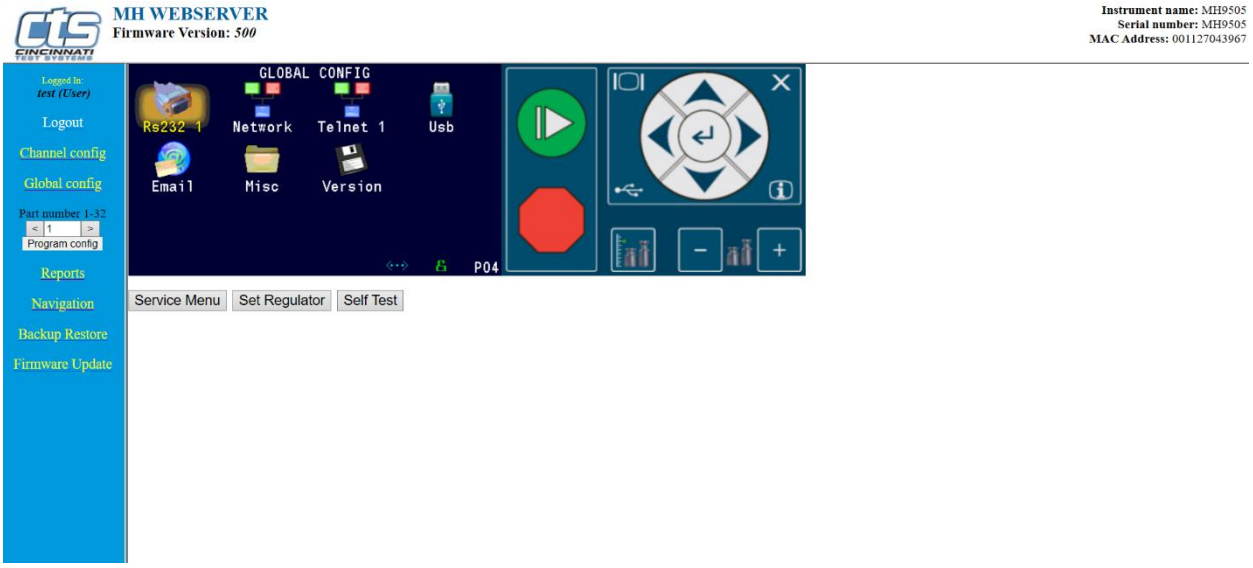


Figure 8 Web Page - Navigation

The **Backup Restore** page allows you to generate a backup of the instrument, generate a backup of all programs, restore a backup, or restore all programs.

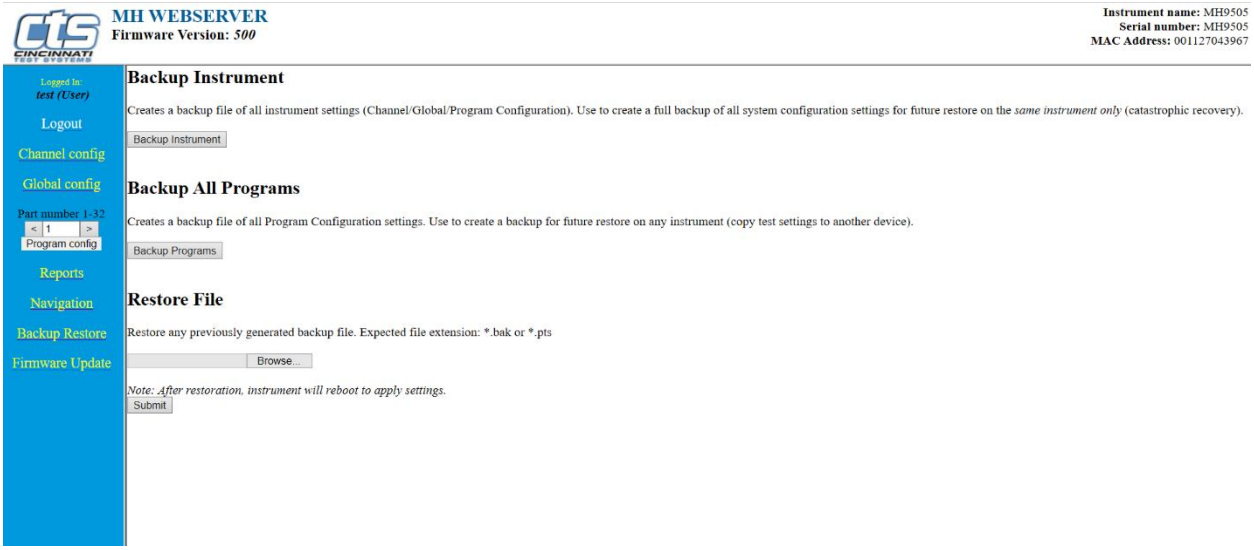


Figure 9 Web Page - Backup/Restore

The **Firmware Update** page allows you to update the instrument's main controller firmware.

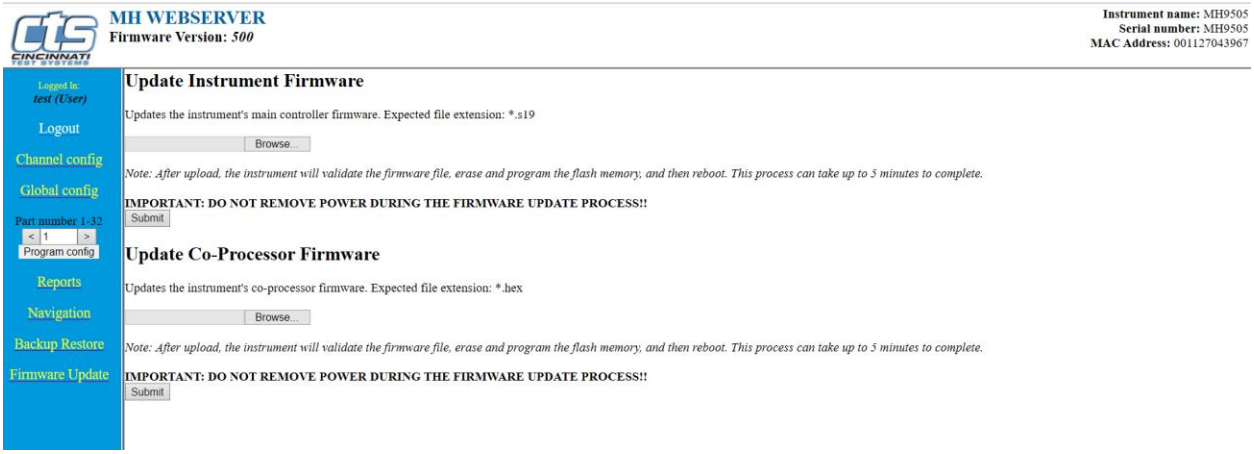


Figure 10 Web Page - Firmware Update

Parameter Configuration via Web Server

You can edit parameters listed on the right section of webpage. Editable parameters, once changed, are highlighted in yellow. After editing any parameter, you will need to click the "Submit" button at the top of the page to make the change on the instrument.

Figure 11 Web page - Editing parameters

Chapter 14 – Security

This chapter explains the instrument security parameters. The Security menu allows flexibility in allowing access or locking functions with a password.

It is located in **Main Menu > Global Config** menu. The **Security** tab may be hidden. To make the Security tab visible, the setting is located in **Main Menu > Global Config > Misc** tab. Select **Edit/View Security**, press **Enter**, use arrows to select "On", and press **Enter**. You will be taken to the Security menu. The Security tab is now visible at the bottom of the Global Config screen.

When the instrument is secured with any of the settings in the Security menu, a password is required to unlock that function of the instrument. The default password is "5555". Anyone with access to this manual will know the default password. To secure the instrument, the password must be changed. Remember to write down the new password. If the new password is forgotten, Cincinnati Test Systems Service department can provide a temporary password to unlock the instrument.

The table below describes the all of the settings in the Security menu.

Parameter	Description	Display User Level
Change Password	Edit allows setting a new password after entering the old password.	Basic Advanced, Admin
Secure Calibration	Applies security to performing a program calibration.	Basic Advanced, Admin
Secure Program Config	Applies security to changing test part parameters.	Basic Advanced, Admin
Secure Global/Chan Config	Applies security to changing instrument configuration parameters.	Basic Advanced, Admin
Secure Clear Data	Applies security to clearing test Result Data from instrument.	Basic Advanced, Admin
Secure Reset Cntrs	Applies security to clearing the counter registers from instrument.	Basic Advanced, Admin
Secure Hold Function	Applies security to hold function.	Basic Advanced, Admin

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Chapter 15 – Features

This chapter explains essential features of the instrument.

Selecting the Display User Level

There are three user levels in the instrument. This is done to minimize the number of items shown on the screen for basic users. More advanced users requiring more features may view these by changing this parameter to the appropriate setting. Throughout the manual the parameter tables have denoted the Display User Level required for viewing and editing access. The **Display User Level** is located in **Main Menu > Global Config > Misc** tab. The three levels are "Basic", "Advanced", and "Admin".

> ***Suggestion: Set the Display User Level to the most basic level for your requirements. Parameters may be locked from editing, see*** Chapter 14 ***– Security.***

Setting the Date & Time

The Date and Time parameters are located in **Main Menu > Global Config > Misc** tab. The date and time are set at the factory. If you are in a different time zone, it may be desirable to change the date and time on the instrument. The date format can be modified with the Date Format parameter. The time format is 24 hour and cannot be changed.

Changing the Instrument Language

The instrument is a multi-language instrument and may be modified. The language setting is located in **Main Menu > Global Config > Misc** tab.

> ***Note: The instrument must be in Advanced or Admin Display User Level to view and modify the instrument Language. To change the Display User Level, see*** Chapter 15 ***– Features.***

Copy & Paste Programs

To simplify the setup, the instrument comes with the ability to copy all of the parameters from one program to another program. Copy Program is located in the **Main Menu > Program Config > Misc** tab of the program you want to copy. Select the **Copy to Target Prog** parameter and press **Enter**. Increment or decrement the target program number where you want to "paste" the program and press **Enter**. Then, change the **Copy Program** parameter to "Yes" and press **Enter**.

> ***Note: The copied program will overwrite all parameters in the target program. Make sure you want to overwrite this program before executing. If a program exists in the target program number, the instrument will prompt to confirm that you want to continue.***

Instrument Backup & Restore

The Backup and Restore function of the instrument is a feature that allows the instrument to create a backup file on a (FAT32) USB memory stick. This can be used to restore the instrument back to its current state. There is no limit to the number of backup files you can have for an instrument. The files are named using the following format: YYMMDD_BLACKBELT_SERIALNUMBER_NUMBER. Backup files are stored in a subfolder named Backup-Restore.

> ***Note: The NUMBER at the end of the backup filename will increment for each backup of the instrument saved on the same day.***

To execute this function, press the USB button on the user interface of the instrument (or press **Main Menu > Global Config > USB** icon). Move the cursor down to the **Backup/Restore** parameter. Make sure a USB memory stick is placed in the USB port on the front of the instrument. Press **Enter** to activate the edit function and select "Backup Instrument". When it is complete, a pop-up window will tell you it was successful.

Program Backup & Restore

The Backup and Restore function of all programs is a feature that allows the instrument to create a backup file on a (FAT32) USB memory stick. This allows you to restore the programs on the instrument to its current state. This also allows you to copy all programs to another instrument with a similar setup. There is no limit to the number of backup files you can have for an instrument. The files are named using the following format: YYMMDD_BLACKBELT_SERIALNUMBER_NUMBER. Backup files are stored in a subfolder named Backup-Restore.

> ***Note: The NUMBER at the end of the backup filename will increment for each backup of the instrument saved on the same day.***

To execute this function, press the USB button on the user interface of the instrument (or press **Main Menu > Global Config > USB** icon). Move the cursor down to the **Backup/Restore** parameter. Make sure a USB memory stick is placed in the USB port on the front of the instrument. Press **Enter** to activate the edit function and select "Backup All Programs". When it is complete, a pop-up window will tell you it was successful.

Instrument Cloning

This function should only be executed under the advice of CTS personnel. This feature is used for service and support of our products. It enables a technician to replicate the exact instrument within our facility to help with any questions or concerns. To execute this function, press the USB button on the user interface of the instrument (or press **Main Menu > Global Config > USB** tab). Move the cursor down to the "Backup/Restore" parameter. Make sure a USB memory stick is placed in the USB port on the front of the instrument. Press **Enter** to activate the edit function and select "Instr Clone". When it is complete a pop-up window will tell you that it was successful.

Leak Standard Functionality

The instrument can be configured optionally with an external leak standard. External leak standards can be driven manually. External leak standard valves may be manually forced open during a test to simulate a leak in the test circuit. Open Leak Std is located in **Main Menu > Channel Config > Leak/Cal** tab. For reference, see Leak Standard Pneumatic Diagrams.

Self-Test

The Self-Test diagnostic provides a way to check the integrity of the instrument's pneumatic circuit. This is a great way to isolate a potential leak by allowing the user to verify the instrument is working correctly. By isolating the instrument from the test part and the external tooling and plumbing, this special test will verify that the instrument is performing properly and leak free.

The Self-Test diagnostic is located in **Main Menu > Channel Config > Self-Test** tab.

Parameter	Description	Display User Level
Self-Test Pressure	Enter the pressure setting of the pressure source chosen to use for the Self-Test diagnostic routine.	Basic Advanced, Admin
Self-Test Source	Specifies the pressure source to utilize for the Self-Test diagnostic routine.	Basic Advanced, Admin
Self-Test Level	The instrument performs two levels of Self-Test. Level 1 is a general integrity test of the pneumatic circuit. Level 2 is more stringent and should be used when testing for low leak or flow rates.	Basic Advanced, Admin
Start Self-Test	Starts the diagnostic routine.	Basic Advanced, Admin

Note: It is important that the test port is plugged with the Self-Test cap during a Self-Test.

Update Firmware

The instrument is able to update the firmware using the USB port on the front of the instrument, or through CTSnet LT. Upon a proper Service request, a firmware update can be sent by an authorized CTS person by email for transfer to a (FAT32) USB memory stick. The file sent will be saved as a ZIP file.

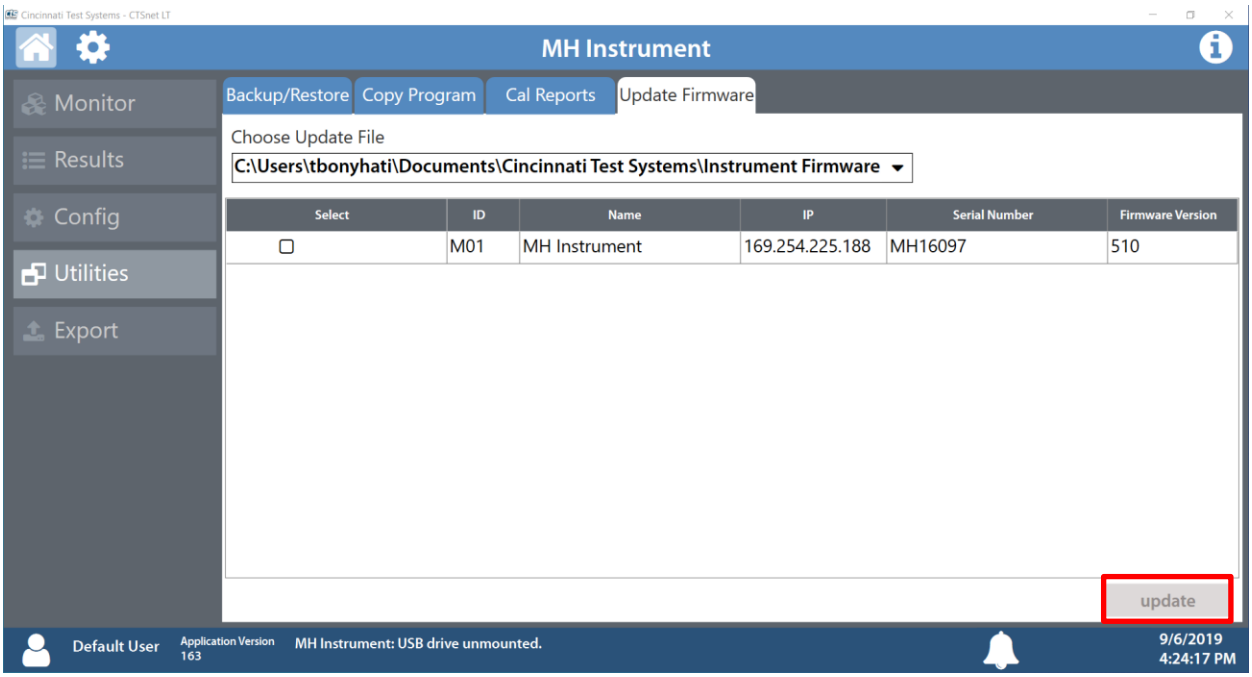
For Telnet/Rs232 Firmware Updates:

Extract the ZIP file to the root directory of the USB memory stick. This step creates the proper folder structure on a USB memory stick. Safely remove the USB memory stick from your computer and insert the stick into the USB port on the front of the instrument.

For CTSnet LT updates:

Extract the zip file to the desired directory on the CTSnet LT PC.

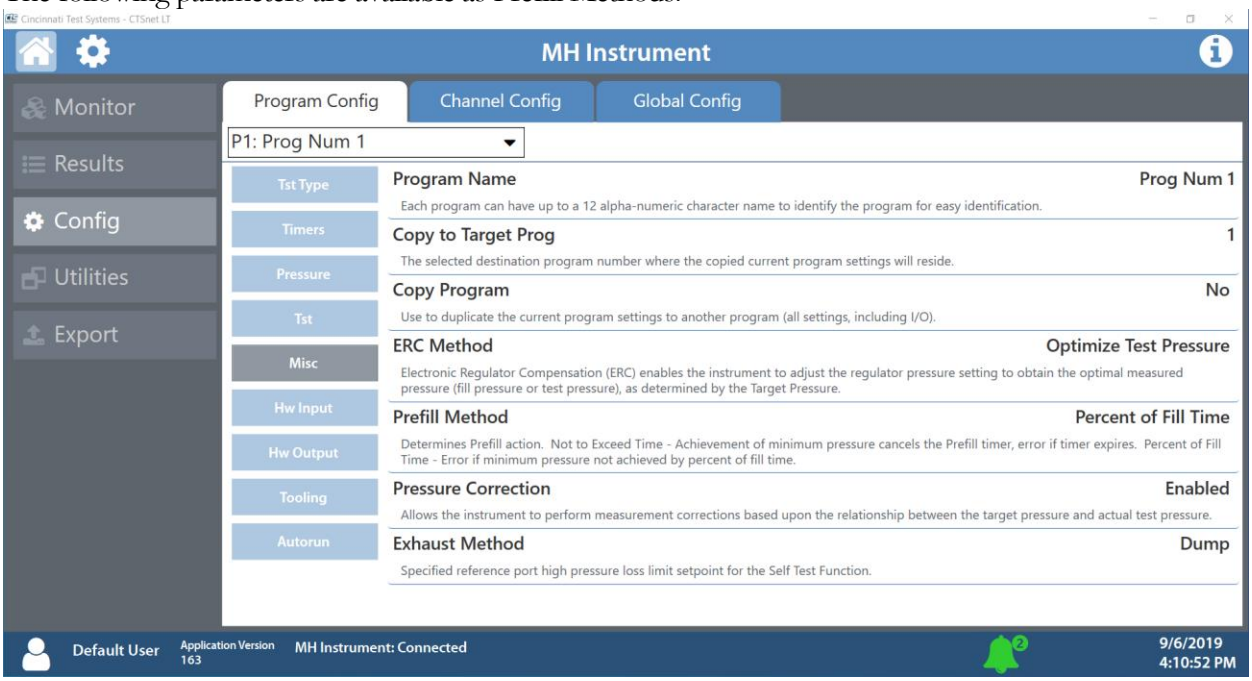
Navigate to the **Utilities > Update Firmware tab and select the Firmware File. Then select the MH instruments to update (if there are multiple) and press update.**



Note: If the firmware version is a minor revision all of the parameter settings will be kept the same. However, if the firmware version is a major revision all of the settings will be cleared. See the firmware documentation to determine if the firmware version you are upgrading from will cause the settings to be cleared. To be safe, always perform a Backup Instrument and Instr Clone before updating firmware.

Prefill Options

The functionality of the prefill portion of test can be modified, based opn the selection of the Prefill Method. The **Prefill Method** configuration is located in **Main Menu > Program Config > Misc** tab. The following parameters are available as Prefill Methods:

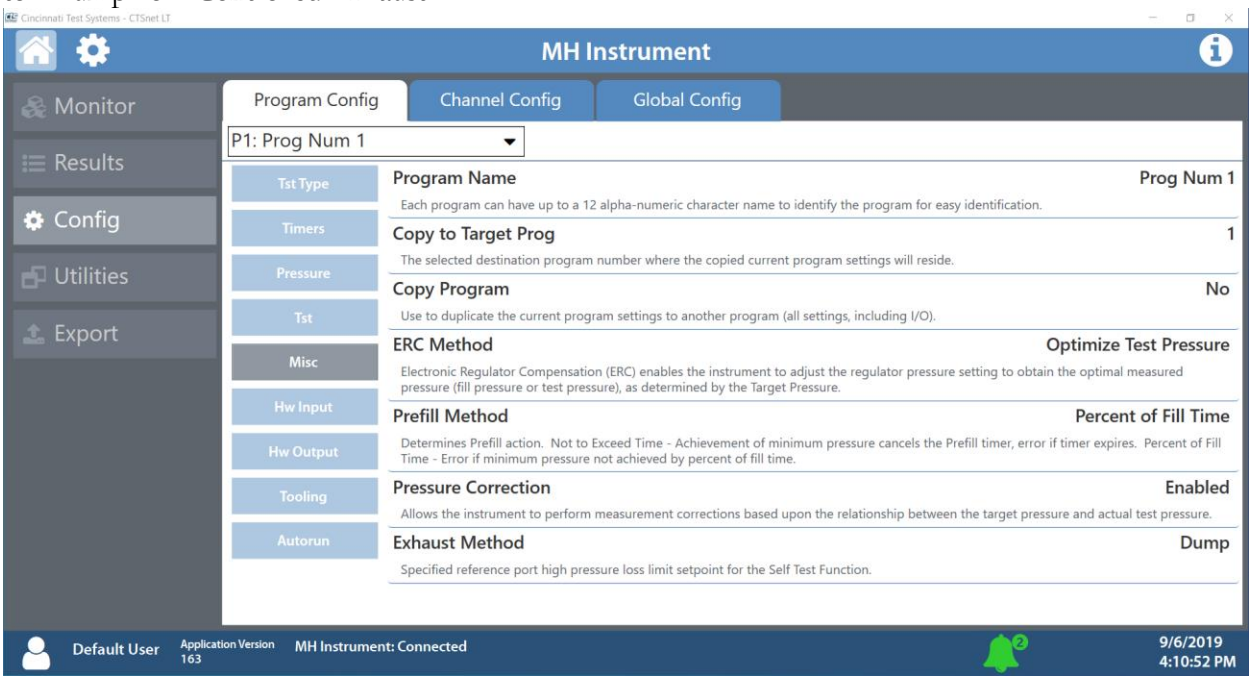


Prefill Method	Description
Percent of Fill Time	The fixed amount of Fill time before which the Minimum Pressure must be met. For example, if the Fill Timer is set to 10 seconds, and the Prefill Timer is set to 80%, then the part must reach Minimum Pressure within 8 seconds. This allows for fixed fill times to be utilized. **This is the default value**.
Not to Exceed Time	The maximum amount of Fill time before which the Minimum Pressure must be met. Once the pressure reaches the Minimum Pressure, the instrument will exit the Prefill segment, regardless of any time remaining, and enter the Fill segment.
Pre-Pressure Time	The amount of time for the instrument to reach the Pre-Pressure value. Once the Pre-Pressure Time has been reached, the instrument will enter the Fill segment and enable the part to reach the Target Pressure. This allows the instrument to fill the part to a different pressure than during the Fill segment. ***Note: This method is available only when Electronic regulator is present in the instrument.***
Controlled Fill	The instrument will begin the cycle in the Prefill Segment and will ramp up the pressure from 0 to the Target Pressure within the Prefill Timer. When the instrument enters the Fill segment, the instrument is at Target Pressure. ***Note: This method is available only when Electronic regulator is present in the instrument.***

Prefill Method	Description
Fixed Charge	The instrument will begin the cycle in the Charge Segment and charge the pneumatic with the desired "Charge Target Press". At the end of the charge timer, pressure much reach "Charge Min Press" and be below "Charge Max Press". Once the Charge Timer has expired, the instrument will enter the Fill segment and fill the part with the charged pneumatic volume.

Exhaust Method

The **Exhaust Method** parameter is located in **Main Menu > Program Config > Misc** tab. It can be set to "Dump" or "Controlled Exhaust".



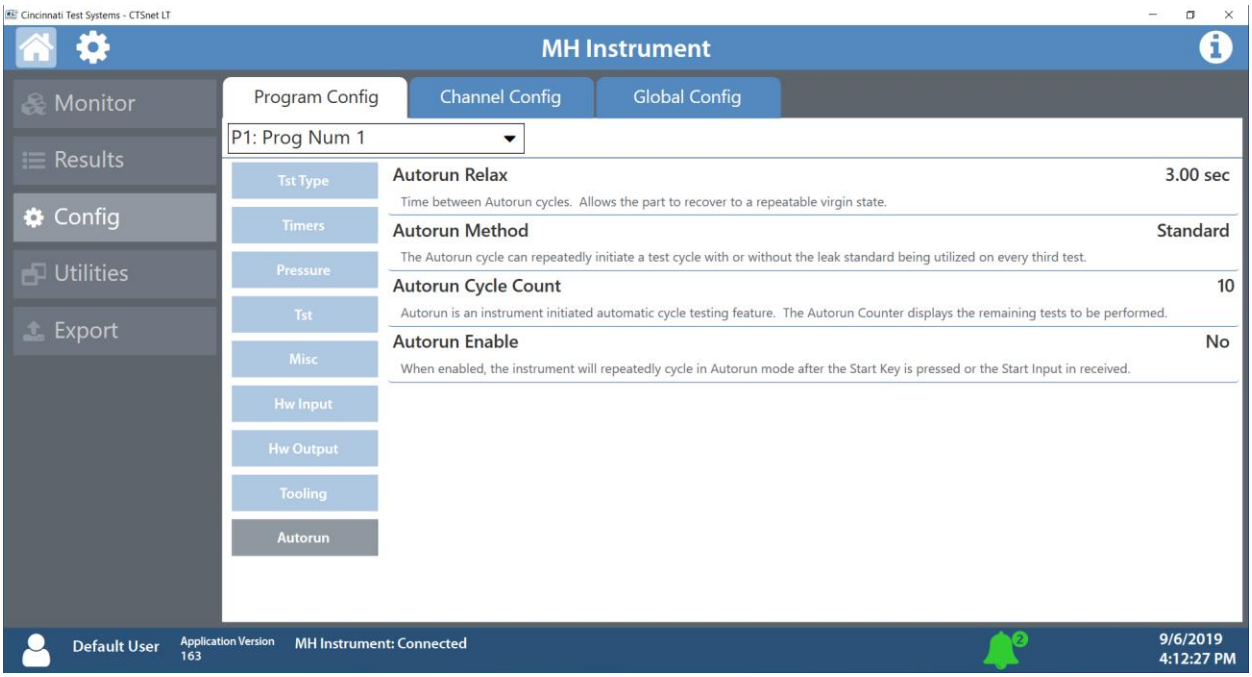
Exhaust Method	Description
Dump	The instrument will open the Exhaust valve and dump the pressure immediately after entering the Exhaust segment. **This is the default value.**
Controlled Exhaust	The instrument will start ramping down the pressure from the last noted instrument pressure to 0 within the specified Exhaust timer. At the end of the Exhaust timer, the instrument will open the Exhaust valve and dump any remaining pressure. ***Note: This method is available only when Electronic regulator is present in the instrument.***

Pressure Correction

In several test types, the instrument uses pressure correction to enhance the performance of the instrument. There are times where pressure correction may not be desirable. For these cases, the instrument has the ability to select whether or not pressure correction is used. It is located in the **Main Menu > Program Config > Misc** tab. Change the **Pressure Correction** parameter to the desired setting.

Autorun

Sometimes it is desired to have the instrument cycle automatically without any need for a person to press the Start button or send a start signal using the digital inputs. The Autorun feature is designed to accomplish this. **Autorun** is located in **Main Menu > Program Config > Autorun** tab. The following menu will display on the screen.



Parameter	Description	Display User Level
Autorun Relax	The amount of time the instrument pauses in between cycles.	Advanced, Admin
Autorun Method	There are two options for this parameter. "Standard" which runs a normal leak test every cycle or "LS on 3rd" which opens the External leak standard (if supplied) every 3rd cycle.	Advanced, Admin
Autorun Cycle Count	The number of cycles left in the Autorun sequence. This parameter is used to determine how many cycles are conducted in an Autorun.	Advanced, Admin
Autorun Enable	When this parameter is set to "Yes" a start command will initiate the Autorun sequence.	Advanced, Admin

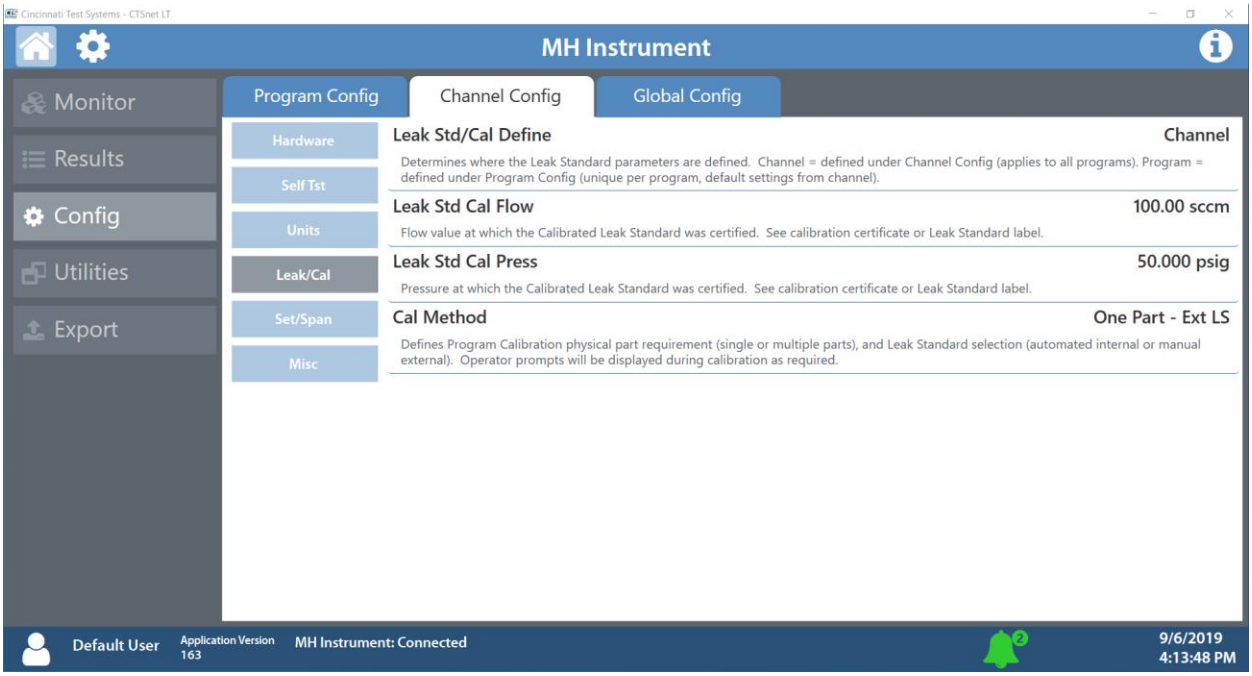
Setting the Cal Method and Leak Standard Location

The **Cal Method** parameter is located in the **Main Menu > Channel Config > Leak/Cal** tab when the **Leak Standard** is set to "Channel". The **Cal Method** parameter is located in the **Main Menu > Program Config > Misc** tab when the **Leak Standard** is set to "Program".

Select Parameter	Description	Explanation
One Part - Ext LS	Manual testing of same part using Leak Standard provided outside the instrument	Tests same non-leaking master part twice; the second time using calibrated leak standard provided externally from the instrument. The instrument will prompt the operator to attach the leak standard when it is time.
Multi-Part – Ext LS	Manual testing of two parts using Leak Standard provided outside instrument	Tests two different non-leaking master parts using the calibrated leak standard provided externally from the instrument. Any tooling must retract between tests to change parts. A Start signal is required either by the user interface or remotely using programmed start test logic to initiate the second test after changing non-leaking master part with leak standard.

Batch Calibration

The Batch Calibration allows multiple calibration sequences to be performed. The results are averaged to calculate the final calibration values. The **Batch Calibration** parameter is located in the **Main Menu > Program Config > Leak/Cal** tab and allows enabling or disabling of batch program calibration mode. When enabled, three more parameters "Batch Layout", "Batch Quantity" & "Average Quantity" are visible to user.



Parameter	Description	Display User Level
Batch Layout	Defines the layout of batch calibration. When Batch Layout is set to "Alternating", which is the default value, the instrument performs the first 'Master' calibration, then the first 'Master+Leak' calibration, then alternates continuously for the remaining batch quantity. When Batch Layout is set to "Grouped", the instrument first performs all 'Masters' calibrations, then all 'Master+Leak' calibrations.	Advanced, Admin
Batch Quantity	Defines the number of calibration sequences in the batch. Minimum value is 2 and maximum value is 25.	Advanced, Admin
Average Quantity	Defines the number of calibration sequences utilized from the Batch quantity to average calibration data. The value must be less than or equal to Batch Quantity.	Advanced, Admin

Chapter 16 – Instrument Calibration

This chapter explains the Set/Span parameters for the pressure transducer and electronic regulator.

Note: Your instrument may not have an electronic regulator.

These parameters are located in **Main Menu > Channel Configuration > Set/Span** tab.

Verifying a Transducer

The transducer verification process is very similar to the calibration process of the respective transducer. You must enter the external master gauge value at each point to step through the sequence. You will be prompted to input values so the ***Transducer Verification Report*** has this data for later review. This feature does not affect the calibration of the instrument.

> ***Note: A Transducer Verification Report may be downloaded from the instrument if desired. See the Reports section on the last page of*** Chapter 12 ***– Communication.***

Calibrating a Transducer

The transducers have been calibrated at the factory. A calibration of the transducer should be done periodically according to the quality standards at your facility. The instrument is capable of performing a multiple point calibration. The number of points is determined by the user. You may select up to 32 points for calibration. You will need a calibrated master pressure gauge to calibrate the transducer on the instrument. On the Set/Span menu select which transducer you want to calibrate. Press Enter to enable the edit function. Change the value to "Yes". The following menu will display on the screen. <Missing Transducer Cal CTSnet LT>

Transducer 1 Cal Menu (Pressure)

Parameter	Description	Display User Level
Number of Points	The number of setpoints to be used for the transducer calibration procedure. Value must be 2 to 32.	Basic Advanced, Admin
Setpoints 2 – 32	The user is able to define the setpoints at which the calibration occurs. The number of setpoints shown is based on the number of points selected in the parameter above.	Basic Advanced, Admin
Linearity Limit	The maximum allowed linearity variance for a successful calibration.	Basic Advanced, Admin
Start Calibration	Commences the calibration procedure. A wizard will walk you through the calibration process.	Basic Advanced, Admin

Transducer 2 Cal Menu (Differential Pressure)

You will need a calibrated master pressure gauge and a calibrated pressure source to calibrate the transducer on the instrument.

Parameter	Description	Display User Level
Number of Points	The number of setpoints to be used for the transducer calibration procedure. Value must be 2 to 32.	Basic Advanced, Admin
Setpoints 2 – 32	The user is able to define the setpoints at which the calibration occurs. The number of setpoints shown is based on the number of points selected in the parameter above.	Basic Advanced, Admin
Linearity Limit	The maximum allowed linearity variance for a successful calibration.	Basic Advanced, Admin
Start Calibration	Commences the calibration procedure. A wizard will walk you through the calibration process.	Basic Advanced, Admin

Note: A Transducer Calibration Report may be downloaded from the instrument if desired. See the Reports section on the last page of Chapter 12 ***– Communication.***

Calibrating an Electronic Regulator

The electronic regulator has been calibrated at the factory. The instrument is capable of doing a multiple point calibration. The number of points is determined by the user. You may select up to 20 points for calibration. You will need a calibrated master pressure gauge to calibrate the electronic regulator on the instrument. On the Set/Span menu select which electronic regulator you want to calibrate. Press Enter to enable the edit function. Change the value to "Yes". The following menu will display on the screen. <Missing Ereg Cal Screen CTSnet LT>

Parameter	Description	Display User Level
Number of Points	The number of setpoints to be used for the Electronic Regulator calibration procedure. Value must be 2 to 20.	Basic Advanced, Admin
Low Limit Voltage	The user is able to define the low voltage for the calibration process.	Admin
High Limit Voltage	The user is able to define the high voltage for the calibration process.	Admin
Start Calibration	Commences the calibration procedure. A wizard will walk you through the calibration process.	Basic Advanced, Admin

Note: The Low Limit Voltage and High Limit Voltage values are disregarded if both are set to "0" (zero is the default setting). You should only change these values if the instrument is not able to automatically analyze the electronic regulator range and perform a proper calibration.

Note: The electronic regulator can remain active in between instrument test cycles or it can be set to "Idle". This parameter is edited by going to Channel Config and selecting the Hardware tab. The parameter is called "E-Regulator Rest" and is available in Basic Display User Level. To change the Display User Level, see Chapter 15 ***– Features.***

Note: An Electronic Regulator Calibration Report may be downloaded from the instrument if desired. See the Reports section on the last page of Chapter 12 ***– Communication.***

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Appendix A – Messages & Error Codes

This appendix is a quick reference for the messages and error codes that display on the screen and through the communication ports.

Test Messages & Errors

Note: For the most up to date Test Messages and Error Codes type "TABLE EVALUATION" into the instrument using the communication port. The instrument will return a list of Data Type Codes and Descriptions. (This table contains the same list of codes found in the 3rd table of Appendix D.)

Message	Code	Description	Corrective Actions
Program Accept	A	Program evaluation was successful, for multiple tests – all tests passed.	
Auto Setup Seq Complete	AC	The Auto Setup Sequence is complete.	
Program Calibration Failed	AF	The test type is one that is capable of conducting a program calibration and this sequence was not successful.	
Master Part Complete	AM	The test type is one that is capable of conducting a program calibration. The first phase of the sequence is complete.	
Program Calibration Passed	AP	The test type is one that is capable of conducting a program calibration and this sequence was successful.	
Error: Anti-tie Down	AT	The two inputs (Start and Common) are not held high during all of the "extend" tooling motions. There is no resultant output.	The two inputs must go high within 0.05 seconds and be held high until the end of all extend tooling motions.
Error: Barcode Req to Start	BR	The instrument was expecting a barcode value to be received over the RS232 port. The Barcode Required parameter was set to "Yes", which requires a barcode before a start command is enabled.	Check barcode reader wiring and functionality. Make sure the Baud Rates are set properly within the instrument.
Master+Leak Loss<Master Loss	C1	During the Program Cal routine, the instrument measured a greater pressure loss for the master part by itself than for the master part with the leak in the second test. This results in a Malfunction.	Increase the stabilization and possibly test time. Verify the leak standard.

Message	Code	Description	Corrective Actions
Master Part Loss>Max Mstr+Leak Loss	C2	The pressure loss during the first test of the Program Cal routine on the master part exceeded the Max Mstr+Leak Loss set point. This results in a Malfunction.	Check the seals and master part for leaks or extend stabilization timer. Check that Max Mstr+Leak Loss was correctly set.
Master +Leak Loss>Max Mstr+Leak Loss	C3	The pressure loss during the second test of the Program Cal routine on the master part exceeded the Max Mstr+Leak Loss set point. This results in a Malfunction.	Check the seals and master part for leaks or extend stabilization timer. Check to leaks about leak standard. Check that Max Mstr+Leak Loss was correctly set.
Master Flow>Max M+L Flow	C4	The flow value during the first test of the Program Cal routine on the master part exceeded the Max Mstr+Leak Flow set point. This results in a Malfunction.	Check the seals and master part for leaks or extend fill or test timers. Check that Max Mstr+Leak Flow was correctly set.
Master Flow<Min Master Flow	C5	The master flow value was less than the Min Master Flow setpoint.	Check that the Min Master Flow setpoint was set correctly. Verify the test line is connected to the test port and not the Self-Test cap.
Master+Leak Flow>Max M+L Flow	C6	The flow value during the second test of the Program Cal routine on the master part exceeded the Max Mstr+Leak Flow set point. This results in a Malfunction.	Check the seals and master part for leaks or extend fill or test timers. Check the leak standard. Check that Max Mstr+Leak Flow was correctly set.
Master Flow>Max Master Flow	C7	The flow value during the first test of the Program Cal routine on the master part exceeded the Max Master Flow set point. This results in a Malfunction.	Check the seals and master part for leaks or extend fill or test timers. Check that Max Master Flow was correctly set.

Message	Code	Description	Corrective Actions
Master+Leak Flow<Master Flow	C8	The flow value during the second test of the Program Cal routine on the master part was less than the measured Master Flow value. This results in a Malfunction.	Check the seals and master part for leaks or extend fill or test timers. Check the leak standard. Check that Max Master Flow was correctly set.
Master Loss<Min Master Loss	C9	The pressure loss reading during the first test of the Program Cal routine for a pressure decay test was less than the Min Master Loss set point. This results in a Malfunction.	Check for blockage in the test line of part.
Cal Program Accept	CA	The Program Calibration was successful.	
Calculation Error	CE	This result occurs from illegal program configurations, calculation errors when trying to convert vacuum pressures to positive pressure readings, and other occurrences.	
Cal Required - Limit Exceeded	CF	Not Used.	
Min Perf Factor Error	CM	The Performance Factor calculated at the end of Program Cal exceeds the Minimum Performance Factor set in the Test Factors.	Check that the Minimum Performance Factor was correctly set. Increase Stabilize and Test timers.
Calibration Required-Parameters Changed	CP	The stabilization or test timers, target pressure, Leak Std Flow, or Leak Std Pressure have been changed since the last calibration and therefore the part needs to be recalibrated. There is no output resultant.	Recalibrate the instrument for this program.
Cal Program Reject	CR	The Program Calibration was not successful.	
DP Transducer Fault	DF	Not Used.	

Message	Code	Description	Corrective Actions
DP Transducer Over Range	DO	Not Used.	
DP Transducer Zero Bad	DZ	Not Used.	
Elec Regulator Cal Complete	EC	The Electronic Regulator Calibration was successful.	
Elec Regulator Cal Error	EE	The Calibration was not successful.	Check the wiring of the electronic regulator. Check that the entry of each pressure calibration point was correct.
Part Evac Fault	EF	Not Used.	
Prog Error	EP	There was an error with the program. Please contact the CTS Service department.	
System Error - Service Req	ER	There was an error with the instrument. Please contact the CTS Service department.	
Flow Transducer Over Range	FO	The flow transducer measured a value out of its range. The instrument stopped the test sequence to prevent damage to the sensor.	
Error: Excessive Flow	FX	The flow transducer measured a value out of its range. The instrument stopped the test sequence to prevent damage to the sensor.	
Flow Transducer Zero Bad	FZ	The flow transducer was not sending the proper voltage. The instrument checks to make sure that the flow transducer is within range before the test sequence begins.	Check the flow transducer wiring. If this happens multiple times, replace the flow transducer.
Helium Background Fault	HF	Not Used.	
Invalid Calibration Data	ID	The calibration data has been corrupted or not properly entered. Please calibrate the unit again.	
I/O Fault	IF	Not Used.	
Invalid I/O Configuration	IO	Not Used.	

Message	Code	Description	Corrective Actions
Invalid Program Selected	IP	The program selected does not exist or has not been configured.	Check BCD Input programming.
Error: Duplicate Target Link	LD	The same child program cannot be in the same link structure. If it is desired to conduct the same test twice you will need to copy the program.	
Master Loss>Max Master Loss	L0	The pressure loss reading during the first test of Program Cal cycle was greater than the Max Master Loss setpoint. This results in a Malfunction.	
Master+Leak Loss<Min Master+Leak Loss	L1	The pressure loss value during the second sequence of Program Cal on the master part was less than the Min Master +Leak Loss setpoint. This results in a Malfunction	
Leak Loss<Min Leak Loss	L2	Measured Leak Loss of Program Cal was less than Min Leak Loss setpoint. This results in a Malfunction.	
Leak Loss >Max Leak Loss	L3	Measured Leak Loss of Program Cal was greater than Max Leak Loss setpoint. This results in a Malfunction	
Leak Std Select Config Error	LE	Configuration Error. The instrument was not configured properly.	
Error: Link Execution Loop	LL	There was an error in the Linking Execution.	Check programming of the Parent/Child Structures.
Error: No Links Defined	LN	The instrument was expecting a link that did not exist.	
Error: Dissimilar Link Order	LO	When the instrument conducts a Program Calibration sequence on linked programs, the links must execute in the same order for both the first and second sequences for Program Calibration.	
Error: Link Program is Parent	LP	A Parent Program may not be a link target.	
Error: Link Prog Undefined	LU	The linked program is undefined.	

Message	Code	Description	Corrective Actions
Error: Part Mark Fault	MF	The part mark feedback input did not receive the input in time.	Check operation of the part marker. Check wiring of the feedback input. Check wiring of the valve to fire the part marker.
No Event Occurred	NE	In a test that is looking for an event, this is the result when one does not occur.	
Above Target Pressure	PA	The instrument will stop conducting a test if the pressure rises above the target pressure window setting.	Check pressure regulator setting, cut seals, bad parts, or tooling control pressure by testing with master part.
Below Target Pressure	PA	The instrument will stop conducting a test if the pressure drops below the target pressure window setting.	Check pressure regulator setting, cut seals, bad parts, or tooling control pressure by testing with master part.
Part Not Changed	PC	The present input signal did not go low between tests to indicate that the part was removed from the fixture after the last test. This results in a Malfunction.	Remove the part after each test.
Part Configuration Error	PE	There was an error in the way the program was configured.	
Part Not Full	PF	This is an error in the Auto Setup Sequence that can occur if the instrument fails to fill the part to the desired pressure.	
Test Pressure High	PH	Test pressure was above the Maximum Pressure during fill or stabilization cycles resulting in a Malfunction.	Check pressure regulator setting and tooling control pressures
Test Pressure Low	PL	Test pressure was below Minimum Pressure during fill cycle. This results in a severe leak.	
Error: Part Not Present	PP	The part present input is set for the active program and the input was not received.	Check the part presence sensor and input wiring

Message	Code	Description	Corrective Actions
Part Not Stabilized	PS	This is an error in the Auto Setup Sequence that can occur if the instrument fails to stabilize the part.	
Part Not Exhausted	PX	This is an error in the Auto Setup Sequence that can occur if the instrument fails to exhaust the part.	
Sequence Complete	QC	Sequence Complete	
Program Reject	R	Program evaluation was not successful, for multiple tests – if any test fails, the part is rejected	
Part Reject - Level 1	R1	Not Used.	
Part Reject - Level 2	R2	Not Used.	
Part Reject - Level 3	R3	Not Used.	
Source Pressure Exceeded	RX	The source pressure set by the factory on the hardware configuration menu was exceeded.	
Stop Button Pressed	SB	The stop button or input was received.	
Start Common Input Low	SC	Not Used.	
Pressure Select Config Error	SE	Configuration Error. The instrument was not configured properly.	
Self-Test Failed	SF	The Self-Test failed	Make sure the test line was removed and the test port plugged before the test was conducted. One of the internal valves may be leaking.
Error: Stop Input High	SH	The instrument cannot start a test if the Stop input is high.	
Stop Input Received	SI	Stop Input Received.	
Severe Leak	SL	Severe Leak indicates the test process did not achieve Minimum Pressure before reaching the Prefill set point or failed to maintain Minimum Pressure during fill or Stabilization timers. This results in a Program Reject.	Check pressure regulator setting, cut seals, bad parts, or tooling control pressure by testing with master part
Self-Test Passed	SP	Self-Test process indicates no internal leak.	

Message	Code	Description	Corrective Actions
System Pressure Exceeded	SX	The system pressure of the unit was exceeded.	Check the pressure source and regulators
Tooling Not Reset	TE	If a tooling error occurs involving any motions, there will be a tooling error. Before the start of the next test, the tooling needs to be reset by the Stop/Reset input. This results in a Malfunction.	Push the Stop/Reset Input and possibly Common to return the tooling to the Start position.
Error: Two-Input Req to Start	TI	Both Start Test and Common must go high to start a test.	
Test Port Select Config Error	TP	The instrument configuration is not correct.	
Error: Tooling not Retracted	TR	The instrument may not start a sequence if all of the tooling is not retracted.	
Tooling Reset	TS	Most tooling errors or some test errors may require a tooling reset with the Stop/Reset input. After completion of the reset, this confirmation message is displayed.	
Error: Tooling not Extended	TX	If the instrument is configured for tooling feedback this error will occur if the tooling feedback input is not received within the time allocated.	Check feedback sensor and input wiring. Make sure the tooling motion feedback timer is set properly.
Vent Part Reset Tooling	VR	Message sent when retain part pressure and tooling are both configured to be used. This message is sent upon a reset.	
Transducer Cal Complete	XC	The transducer calibration is complete and was successful.	
Transducer Cal Error	XE	There was an error when trying to calibrate the transducer.	Check transducer wiring
Pressure Transducer Fault	XF	Not used.	
External Switch did not go high	XH	The External Pressure Switch input did not go high before the end of the fill timer. This results in a Malfunction.	Check the pressure switch. Make sure that the path to the pressure switch is not blocked.
External Switch did not go low	XL	The External Pressure Switch input did not go low between tests. This results in a Malfunction.	Check pressure switch to make sure it is functioning.

Message	Code	Description	Corrective Actions
Transducer Over Range	XO	During the testing process the pressure exceeded the range of the transducer. This results in a Malfunction.	Check the pressure regulator setting
Transducer Verify Complete	XV	The transducer verification sequence is complete.	
Transducer Zero Bad	XZ	The pressure transducer's atmospheric pressure reading at the beginning of the testing cycle is outside of tolerance. This results in a Malfunction.	Perform transducer calibration routine in Self-Test

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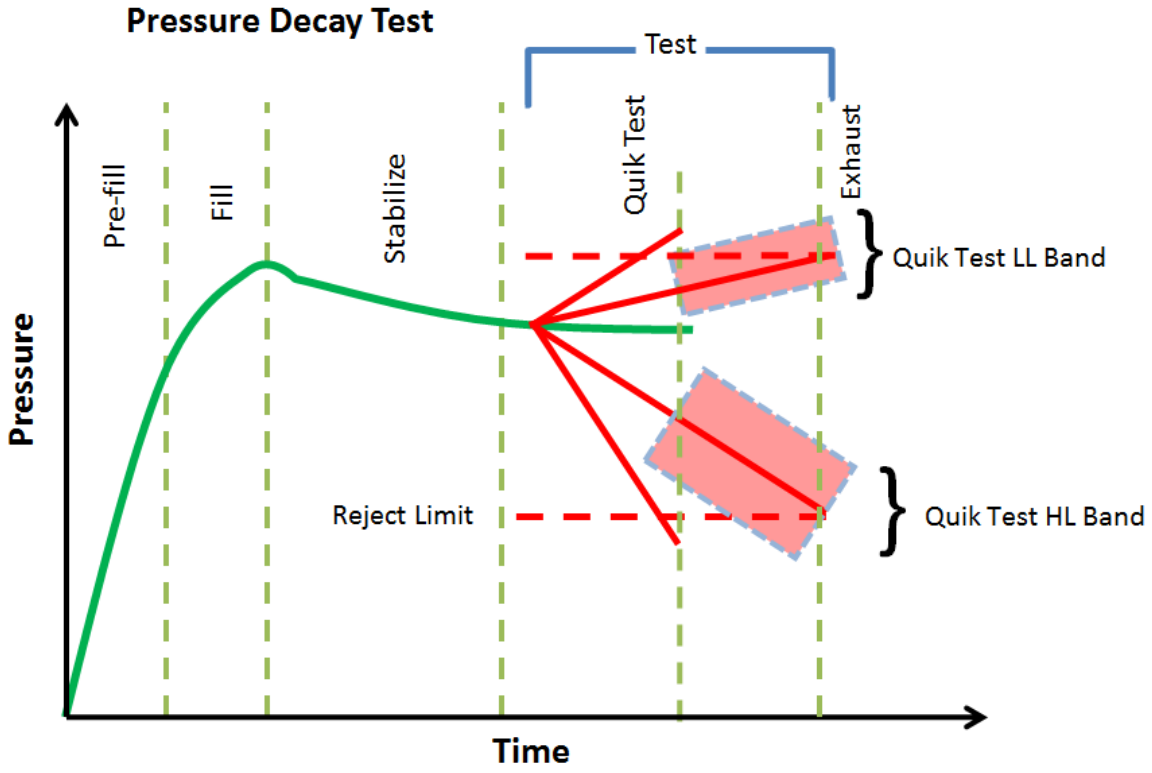
Appendix B – Quik Test

This appendix explains the theory and parameters for reducing the test time for obviously good and obviously bad parts, without sacrificing the accuracy for marginal parts. This capability is called Quik Test in the instrument. Quik Test is available in the Pressure Decay-Leak Std test type that conducts a Program Calibration using a leak standard.

How it works

Most manufacturing processes produce the desired quality of product a high majority of the time. These parts easily pass the leak test being performed on them. Conversely, most defective parts reject by a wide margin. Quik Test monitors the pressure or flow signal during the test and ends the test early for parts that easily pass or easily reject. Any marginal parts that are within the parameters set by the Quik Test HL (High Limit) Band and Quik Test LL (Low Limit) Band will utilize the entire Test time to ensure the accuracy of the result.

At the desired time in the Test sequence determined by the Quik Test Percent parameter the instrument calculates the projected leak rate and compares it with the Quik Test Low Limit and High Limit Bands. If the projected leak rate is within either of these two bands, the test continues to the end of the test timer. If the instrument's projected leak rate is outside of these bands, it will stop the test, output the results according to the Test Evaluation criteria, and display the projected leak rate.



The prior chart shows the master part curve, the Low Limit with its Quik Test LL band limit, and the High Limit with its Quik Test HL band limit. If the pressure loss is within either the Quik Test LL band or Quik Test HL band at the QT% of Test Timer, the test will continue and complete the entire test cycle. If the results are outside the limit bands at the QT% of Test Timer, the test will stop, and the test result will reflect the Test Evaluation criteria. Setting narrow bands about the Low Limit and High Limit is a very aggressive approach that will greatly limit the number of tests that run to the end of the test timer. Set wider bands as a more conservative approach to Quik Test.

An initial analysis of Quik Test should be performed before actually implementing this feature by establishing the "QT Test Timer" at 10, 25, 50, 75, or 90% and setting "Quik Test" to OFF. A Program Calibration must be performed after setting the "Quik Test Timer" to measure the typical leak response curve for the test. Test production parts over a reasonable time (up to 1000 parts in various production conditions). The instrument projects a leak rate at the Quik Test Timer and then completes the full test cycle and calculates the leak rate for the complete test. The instrument stores the test results that include both the actual complete test result and a projected test result based on the Quik Test measurement. By comparing the two leak rate results, a percent of error for the Quik Test feature can be calculated. If the results are satisfactory, the Quik Test feature can be implemented by setting appropriate High Limit and Low Limit Bands based on the test comparison and enabling Quik Test. This feature will save the time difference between a full test time and the Quik Test Time for almost all of the accepted parts and most of the rejected parts. If the results are not consistent to each other, test further by increasing the Quik Test Timer, re-calibrate the instrument, and compare the results again.

Test Parameters

The Quik Test parameters menu is located in **Main Menu > Program Config > TST:***** tab.

TST Parameter	Description	Display User Level
Quik Test Enable	Activates Quik Test.	Advanced, Admin
Quik Test Timer	Defines the time as a percent of the Test sequence when the Quik Test function result is calculated.	Advanced, Admin
Quik Test LL Band	The leak (flow) rate band around the Low Limit within which the tests will continue to completion. This value is the amount above and below the nominal. For example, if this value is set to 0.5 scc/m and the Low limit is set to -5.0 scc/m, the entire Quik Test LL Band is -4.5 to -5.5 scc/m.	Advanced, Admin
Quik Test HL Band	The leak (flow) rate band around the High Limit within which the tests will continue to completion. This value is the amount above and below the nominal. For example, if this value is set to 1.0 scc/m and the High limit is set to 10.0 scc/m, the entire Quik Test LL Band is 9.0 to 11.0 scc/m.	Advanced, Admin

Appendix C – Environmental Drift Correction

This appendix explains the theory and parameters for implementing the Environmental Drift Correction feature.

How it works

The environmental drift correction routine helps to maintain the calibration of the system by continuously monitoring and calculating a correction factor for changes in the test conditions. This routine dynamically compensates for slow changes in the test environment such as room temperature changes, part temperature changes, test air temperature changes, part elasticity changes, part absorption characteristics, etc. These factors influence the dynamics of how the test part reacts to the testing process and the determination of the leak rate. "Environmental Drift Correction" defines how wide of a band around the Master Part Loss or Master Part Flow value will be considered as normal variations in flow rate for a non-leaking part. The "Environmental Drift Correction" (+EDC %) is based on High Limit. The instrument continuously calculates a running average of test results that fall within the band (EDC %) about the original non-leaking master part curve. It corrects each future result by the calculated drift determined from previous test results. The drift value is calculated as shown.

$$\text{Environmental Drift Correction} = \frac{\Sigma n \text{ Flow}}{n} - \text{"Master Part Flow"}$$

Typical settings for "Environmental Drift Correction" are 10%, 25%, 50%, 75%, and 90%. The sample size is set as EDC quantity (3 or greater). Flexible parts require a greater "Environmental drift correction" than rigid parts.

The "Environmental Drift Correction" effectively defines how much shift can occur. This limits the routine from continuing to compensate for possible growing leaks in the seal or test pneumatics.

The EDC parameters menu is located in **Main Menu > Program Config > TST:***** tab.

TST:*** Parameter	Description	Display User Level
EDC Enable	Enables Environmental Drift Correction	Advanced, Admin
EDC Percentage	Defines the band about the master part curve where test values are saved to calculate EDC drift. Set as a percentage of the High Limit parameter.	Advanced, Admin
EDC Quantity	Defines the number of test results within the EDC band used to calculate drift.	Advanced, Admin

Environmental Drift Correction (EDC) will reset based on any of the following conditions:

1. Instrument power-cycle (due to limitations in instrument non-volatile storage)
2. Change of any variables that affect EDC calculations:
    a. EDC Configuration change (modification of the variables: *EDC Enabled*, *EDC Percentage*, or *EDC Quantity*)
    b. Test Limit change (modification of the variable: *High Limit [Loss/Leak/Rate]*)
3. Program idle time-out: 1 hour elapsed since last test on matching program number

Note: The act of changing the selected active program does not reset the Environmental Drift Correction feature. A user can switch between multiple programs (EDC data is stored per program), as long as the amount of time from the last time the similar program number was run does not exceed the 1-hour time-out.

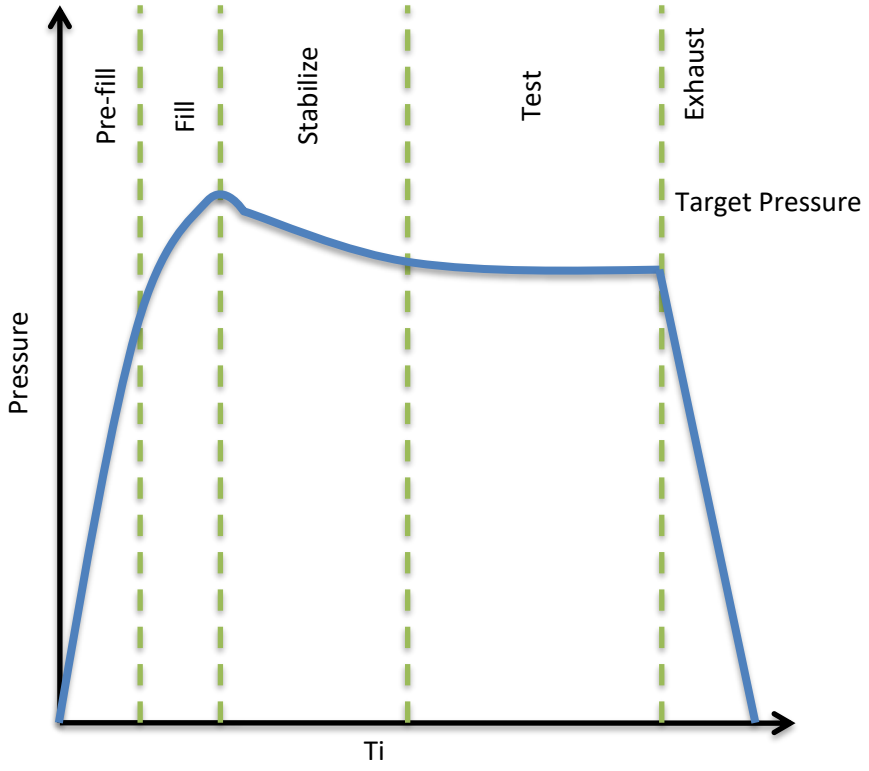
Appendix D – Electronic Regulator Compensation

This appendix explains the theory and parameters for implementing the Electronic Regulator Compensation (ERC) feature.

How it works

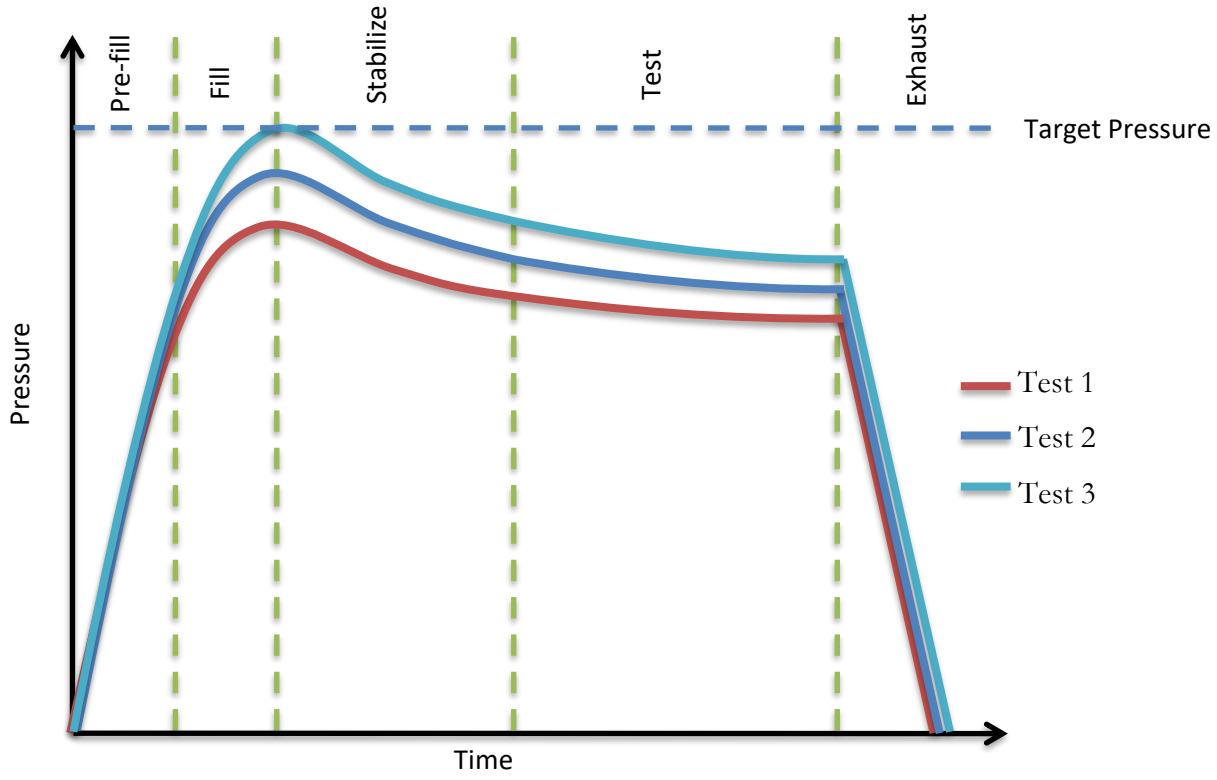
The Electronic Regulator Compensation (ERC) routine helps the instrument to compensate for electronic regulator calibration error (drift from calibrated setpoint). This allows the instrument to reach the desired target pressure. The ERC method can be set to "*Optimize* Fill *Pressure*", "*Optimize* Test *Pressure*", or "*Optimize Source Pressure*".

The below graph represents a test with ERC disabled. In this example, the electronic regulator is not calibrated for Target Pressure, so the pressure set during the test has deviated.



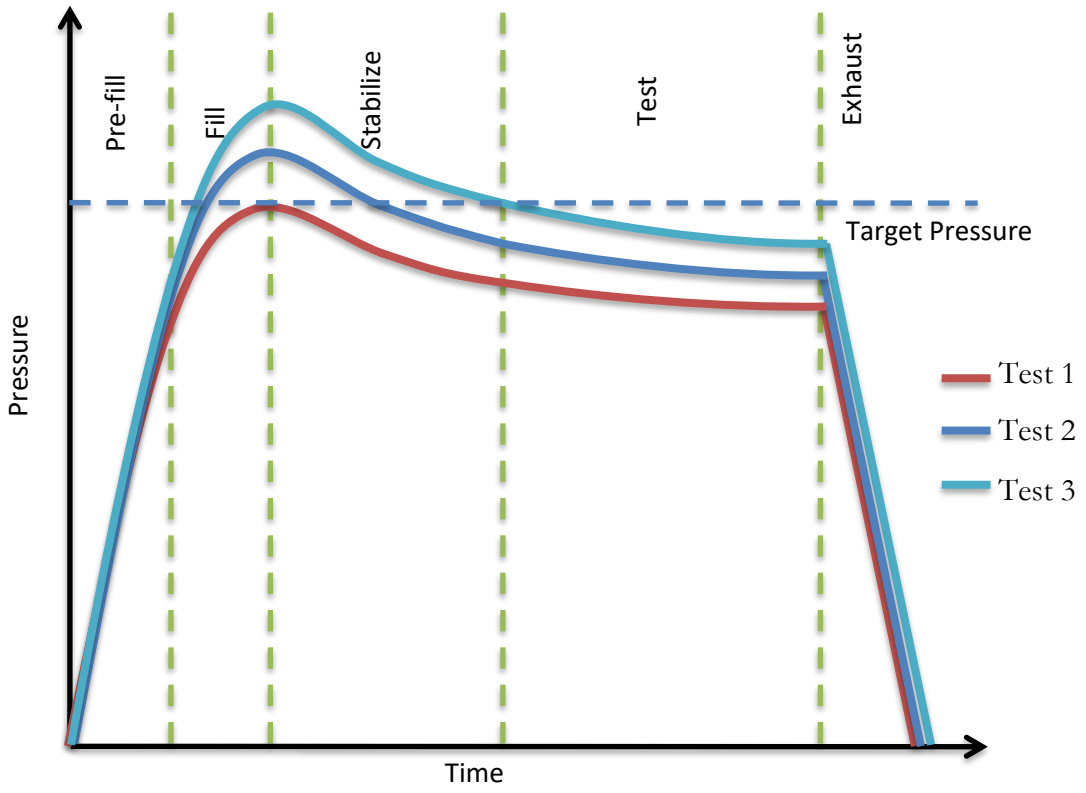
In the "Optimize Fill Pressure" method, ERC enables the instrument to adjust the regulator pressure setting to obtain the **optimal measured fill pressure**, as determined by the Target pressure.

In this method, the electronic regulator setpoint is adjusted on subsequent tests to force the measured fill pressure to match the target pressure, based upon the stored result history of previous passed tests.

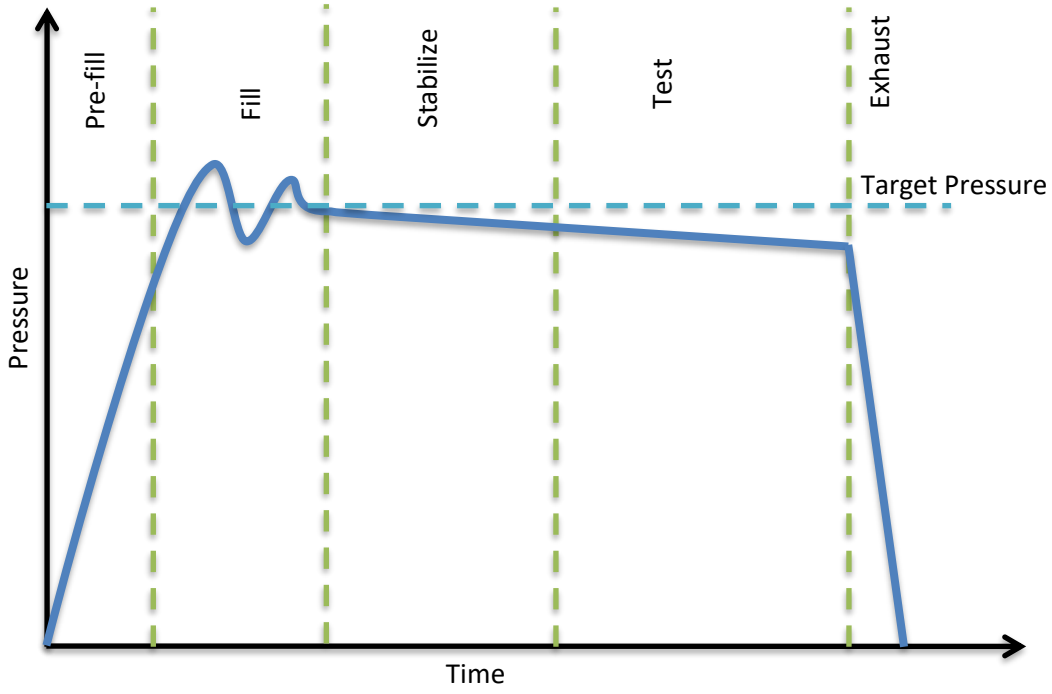


In the "Optimize Test Pressure" method, ERC enables the instrument to adjust the regulator pressure setting to obtain the **optimal measured test pressure**, as determined by the Target pressure.

In this method, the electronic regulator setpoint is adjusted on subsequent tests to force the measured test pressure to match the target pressure, based upon the stored result history of previous passed tests.



In the "Optimize Source Pressure" method, the electronic regulator will be continuously adjusted during the fill segment to force the measured fill pressure to match the desired target pressure for the test.



Note:

1. ***The performance of "Optimize Test Pressure" or "Optimize Fill Pressure" methods depends on multiple iterations since it is based on the history of previous Accept tests. For these ERC methods, only tests that pass with the measured pressure that is inside the ERC target window will be added to the history.***
2. ***The "Optimize Source Pressure" method does not depend on the history of previous Accept tests. Every time you run this test, the instrument will regulate pressure to the desired target pressure for that test only.***

ERC will reset based on any of the following conditions:

1. Instrument power-cycle (due to limitations in instrument non-volatile storage)
2. Change of any variable that affect ERC calculation
    a. ERC Method
    b. ERC Target Window
    c. ERC Offset Limit
    d. ERC Quantity

Test Parameters

The ERC Test parameters menu is located in **Main Menu > Program Config > MISC** tab.

TST Parameter	Description	Display User Level
ERC Method	ERC method enables the instrument to adjust the regulator pressure setting to obtain the optimal measured pressure (fill pressure or test pressure), as determined by the Target Pressure.	Advanced, Admin
ERC Target Window	Percentage (plus and minus) window about the target pressure, defining the maximum allowable test pressure to be utilized in the calculation for the ERC routine. *This parameter is only available if the ERC Method selected is "Optimize Test Pressure" or "Optimize Fill Pressure"*	Admin
ERC Offset Limit	Maximum correction value, defined as a percentage of the target pressure, allowed for the ERC routine. *This parameter is only available if the ERC Method selected is "Optimize Test Pressure" or "Optimize Fill Pressure"*	Admin
ERC Quantity	Maximum number of test results within the ERC target window used to calculate the ERC pressure offset. *This parameter is only available if the ERC Method selected is "Optimize Test Pressure" or "Optimize Fill Pressure"*	Admin
ERC Increment Limit	Limits the maximum electronic regulator incremental adjustment for the ERC routine, Defined as the percentage of the window between the target pressure and the min/max pressure. *This parameter is only available if ERC Method selected is "Optimize Source Pressure"*	Admin
ERC Crossover Limit	Defines the number of times the pressure must crossover the desired target pressure when determining the period response rate of the electronics regulator. *This parameter is only available if ERC Method selected is "Optimize Source Pressure"*	Admin
ERC Rate/Period	Percentage of the electronic regulator response period used to determine the ERC routine response rate *This parameter is only available if ERC Method selected is "Optimize Source Pressure"*	Admin

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Appendix E – Communication Code Tables

This appendix lists the codes that are referenced in the notes of Chapter 11 –Communication.

Each table can be generated within the communications interface by providing the associated command denoted.

Data Type Codes or Header Codes

type "TABLE HEADER"

	Data Type Code	Description
1	V	Variable Edit
2	L	List
3	M	Message
4	Q	Result List
5	T	Streaming Started
6	S	Streaming Value
7	X	Streaming Stopped
8	R	Result Value

Program Evaluation Codes

type "TABLE RESULT"

	Program Evaluation Code	Description
1	P	TEST PASSED
2	F	TEST FAILED
3	E	TEST ERROR
4	S	TEST SKIPPED
5	X	TEST FAILED - LEVEL 1
6	Y	TEST FAILED - LEVEL 2
7	Z	TEST FAILED - LEVEL 3
8	M	AUTO-CAL MASTER PART
9	L	AUTO-CAL LEAK STANDARD PART
10	N	TEST FAILED - NO EVENT
11	C	TEST COMPLETE

Test Evaluation Codes

type "TABLE EVALUATION"

	Test Evaluation Code	Description
1	A	PROGRAM ACCEPT
2	AC	AUTOSETUP SEQ COMPLETE
3	AF	PROGRAM CALIBRATION FAILED
4	AL	MASTER+LEAK PART COMPLETE
5	AM	MASTER PART COMPLETE
6	AP	PROGRAM CALIBRATION PASSED
7	AT	ERROR: ANTI-TIE DOWN
8	BR	ERROR: BARCODE REQ TO START
9	C1	MASTER+LEAK LOSS<MASTER LOSS
10	C2	MASTER LOSS>MAX M+L LOSS
11	C3	MASTER+LEAK LOSS>MAX M+L LOSS
12	C4	MASTER FLOW>MAX M+L FLOW
13	C5	MASTER FLOW<MIN MASTER FLOW
14	C6	MASTER+LEAK FLOW>MAX M+L FLOW
15	C7	MASTER FLOW>MAX MASTER FLOW
16	C8	MASTER+LEAK FLOW<MASTER FLOW
17	C9	MASTER LOSS<MIN MASTER LOSS
18	CA	CAL PROGRAM ACCEPT
19	CE	CALCULATION ERROR
20	CF	CAL REQUIRED - LIMIT EXCEEDED
21	CH	CHARGE PRESSURE HIGH
22	CL	CHARGE PRESSURE LOW
23	CM	MIN PERF FACTOR ERROR
24	CP	CAL REQUIRED - PARAM CHANGED
25	CR	CAL PROGRAM REJECT
26	CX	CHAMBER EVACUATION FAULT
27	DF	DP TRANSDUCER FAULT
28	DO	DP TRANSDUCER OVER-RANGE
29	DZ	DP TRANSDUCER ZERO BAD
30	EC	ELEC REGULATOR CAL COMPLETE

	Test Evaluation Code	Description
31	EE	ELEC REGULATOR CAL ERROR
32	EF	PART EVAC FAULT
33	EI	ERROR: INSTRUMENT NOT ENABLED
34	EP	PROG ERROR
35	ER	SYSTEM ERROR - SERVICE REQ
36	FC	CHAMBER PRESSURE HIGH
37	FO	FLOW TRANSDUCER OVER-RANGE
38	FX	ERROR: EXCESSIVE FLOW
39	FZ	FLOW TRANSDUCER ZERO BAD
40	HF	HELIUM BACKGROUND FAULT
41	IC	INVALID INPUT CONFIGURATION
42	ID	INVALID CALIBRATION DATA
43	IE	INPUT INITIAL STATE ERROR
44	IF	I/O FAULT
45	IO	INVALID I/O CONFIGURATION
46	IP	INVALID PROGRAM SELECTED
47	IR	CHAMBER RISE INPUT FAULT
48	IS	ISOLATION FAILURE
49	IX	CHAMBER CROSSOVER INPUT FAULT
50	L0	MASTER LOSS>MAX MASTER LOSS
51	L1	MASTER+LEAK LOSS<MIN M+L LOSS
52	L2	LEAK LOSS<MIN LEAK LOSS
53	L3	LEAK LOSS>MAX LEAK LOSS
54	L4	MASTER+LEAK FLOW<MIN M+L FLOW
55	L5	LEAK FLOW<MIN LEAK FLOW
56	L6	LEAK FLOW > MAX LEAK FLOW
57	LD	ERROR: DUPLICATE TARGET LINK
58	LE	LEAK STD SELECT CONFIG ERROR
59	LL	ERROR: LINK EXECUTION LOOP
60	LN	ERROR: NO LINKS DEFINED

type "TABLE EVALUATION"

	Test Evaluation Code	Description
61	LO	ERROR: DISSIMILAR LINK ORDER
62	LP	ERROR: LINK PROG IS PARENT
63	LU	ERROR: LINK PROG UNDEFINED
64	MC	MASS SPEC CONTAMINATION
65	MF	ERROR: PART MARK FAULT
66	MS	MAN FILL SWITCH
67	NE	NO EVENT OCCURRED
68	OC	ATMOSPHERIC PRESSURE COMPLETE
69	OE	ATMOSPHERIC PRESSURE ERROR
70	PA	ABOVE TARGET PRESSURE
71	PB	BELOW TARGET PRESSURE
72	PC	ERROR: PART NOT CHANGED
73	PE	PROGRAM CONFIGURATION ERROR
74	PF	PART NOT FULL
75	PH	TEST PRESSURE HIGH
76	PL	TEST PRESSURE LOW
77	PP	ERROR: PART NOT PRESENT
78	PR	POWER RESET
79	PS	PART NOT STABILIZED
80	PV	PROCESS FAULT
81	PX	PART NOT EXHAUSTED
82	QC	SEQUENCE COMPLETE
83	R	PROGRAM REJECT
84	R1	PART REJECT - LEVEL 1
85	R2	PART REJECT - LEVEL 2
86	R3	PART REJECT - LEVEL 3
87	RF	CHAMBER RISE FAULT
88	RH	PRE-PRESSURE HIGH
89	RL	PRE-PRESSURE LOW
90	RX	SOURCE PRESSURE EXCEEDED

	Test Evaluation Code	Description
91	S1	LD ZERO < MIN
92	S2	LD ZERO > MAX
93	S3	LD LEAK < MIN
94	S4	LD LEAK > MAX
95	SB	STOP BUTTON PRESSED
96	SC	START COMMON INPUT LOW
97	SE	PRESSURE SELECT CONFIG ERROR
98	SF	SELF-TEST FAILED
99	SH	ERROR: STOP INPUT HIGH
100	SI	STOP INPUT RECEIVED
101	SL	SEVERE LEAK
102	SM	SNIFFER MODE MISMATCH
103	SN	ERROR: SNIFFER NOT READY
104	SP	SELF-TEST PASSED
105	SR	SNIFFER READY INPUT FAULT
106	ST	SNIFFER TYPE MISMATCH
107	SU	SNIFFER UNITS MISMATCH
108	SX	SYSTEM PRESSURE EXCEEDED
109	TB	T-GAS BACKGROUND FAULT
110	TC	T-GAS CHAMBER CLEANUP FAULT
111	TE	ERROR: TOOLING NOT RESET
112	TF	T-GAS PART FILL FAULT
113	TI	ERROR: TWO-INPUT REQ TO START
114	TL	T-GAS LEAK STD FAULT
115	TM	T-GAS MIN LEAK RATE FAULT
116	TP	TEST PORT SELECT CONFIG ERROR
117	TR	ERROR: TOOLING NOT RETRACTED
118	TS	TOOLING RESET
119	TX	ERROR: TOOLING NOT EXTENDED
120	VF	VALVE LOAD FAULT

type "TABLE EVALUATION"

	Test Evaluation Code	Description
121	VR	VENT PART RESET TOOLING
122	WA	WEIGHT ABOVE MAX
123	WB	WEIGHT BELOW MIN
124	WC	SCALE CONFIG ERROR
125	WH	SCALE WEIGHT HIGH
126	WL	SCALE WEIGHT LOW
127	WR	SCALE NOT READY
128	WS	SCALE NOT STABLE
129	XC	TRANSDUCER CAL COMPLETE
130	XE	TRANSDUCER CAL ERROR
131	XF	PRESSURE TRANSDUCER FAULT
132	XH	EXT SWITCH DID NOT GO HIGH
133	XL	EXT SWITCH DID NOT GO LOW
134	XO	TRANSDUCER OVER-RANGE
135	XP	EXTERNAL XDCR PRESS
136	XV	TRANSDUCER VERIFY COMPLETE
137	XZ	TRANSDUCER ZERO BAD

Segment Codes

type "TABLE SEGMENT"

	Segment Code	Description
1	%VR	Percent of Reference Volume Test
2	APC	Setup - Atmospheric Pressure Check
3	AR	Autorun Relax
4	BAL	Stabilize DP Xdcr Balance
5	CBC	Chamber - blower control
6	CC0	Chamber - circulation off
7	CC1	Chamber - circulation on
8	CCX	Chamber - accumulation rest
9	CE0	Chamber - evacuate off
10	CE1	Chamber - evacuate on
11	CHA	Exhaust - Chamber Output Rest
12	CIF	Chamber - inlet blower off
13	CIO	Chamber - inlet blower on
14	CLN	Stabilize Chamber Cleanup
15	CO0	Chamber - outlet blower off
16	CO1	Chamber - outlet blower on
17	CP0	Chamber - pre-purge
18	CPC	Chamber - clamshell purge rings control
19	CPG	Chamber - Exh/Purge
20	CPO	Chamber - clamshell purge rings option
21	CPR	Chamber - clamshell purge rings rest
22	CST	Fill Clean
23	CV0	Chamber - vent off
24	DDL	Differential Pressure Decay - Leak Rate (volume calculated)
25	DLY	Delay
26	DPD	Differential Pressure Decay Test
27	DPD	Differential Pressure Decay Test (no abs pressure)
28	DPL	Differential Pressure Decay - Leak Standard Test (no abs pressure)
29	PS	Differential Pressure Decay - Leak Standard Test
30	DPT	Setup - DP Transducer Setpoint

	Segment Code	Description
31	DPT	Rate of Pressure Loss Test
32	DTV	Setup - DP Transducer Verification
33	DTZ	Setup - DP Transducer Zero
34	ERA	Setup - Electronic Regulator Analyze
35	ERS	Setup - Electronic Regulator Setpoint
36	ERZ	Setup - Electronic Regulator Zero
37	ESI	Internal - Empty-Seq
38	EST	Fill Evac
39	EXE	Exhaust until Empty
40	EXH	Exhaust
41	EXP	Exhaust until Pressure
42	EXT	Tooling Motion Extend
43	FFL	Fill until Full
44	FGN	General Fill
45	FLC	Mass Flow - Leak Rate Test
46	FLL	Fill (without pressure monitoring)
47	FLR	Precise Mass Flow Test (Differential Flow)
48	FLW	Mass Flow Test
49	FRF	Fill Reference
50	FRP	Fill Ramp
51	FST	Fill Tracer
52	FTS	Setup - Flow Transducer Setpoint
53	FTV	Setup - Flow Transducer Verification
54	FTZ	Setup - Flow Transducer Zero
55	HVC	Chamber - hardvac control
56	LKC	Link Control
57	LNK	Link Decision
58	MVX	Setup - Mix Verification
59	OCC	Occlusion Test (Backpressure)
60	PLO	Pressure Loss Test

type "TABLE SEGMENT"

	Segment Code	Description
61	PLR	Pressure Decay - Leak Standard Test
62	PMK	Tooling Part Mark
63	PRC	Prefill - Charge Volume
64	PRF	Prefill/Fill
65	PRF	Prefill until Pressure
66	PRF	Proof Test
67	PRI	Internal - Pre-Seq
68	PRI	Internal - Evaluate Part Result
69	PRP	Prefill Pre-Pressure
70	PRS	Step Proof
71	PSI	Internal - Post-Seq
72	PTS	Setup - Pressure Transducer Setpoint
73	PTV	Setup - Pressure Transducer Verification
74	PTZ	Setup - Pressure Transducer Zero
75	PVF	Pressure Verify
76	RCF	Refrigerant Iso Off
77	RCX	Refrigerant CS Isolation
78	REC	Exhaust - T-Gas
79	REF	Refrigerant Fill
80	RET	Tooling Motion Retract
81	REV	Exhaust - Re-Evacuate
82	RFE	Refrigerant Evac
83	RFM	Refrigerant Manual Fill
84	RFS	Stabilize Scale
85	RFT	Refrigerant Fill
86	RFX	Refrigerant Stabilize
87	RL	Calibration Relax
88	RPS	Refrigerant Part Switch
89	RTE	Ramp to Pressure Event Test
90	RTF	Ramp to Flow Event Test

	Segment Code	Description
91	RTI	Ramp to Digital Input Event Test
92	RVN	Refrigerant Vent
93	SCI	Setup - Scale Init
94	SD1	Setup - Sniffer idle
95	SDP	Stabilize for DP
96	SDP	Stabilize Balance DP
97	SFS	Stabilize Tracer
98	SGL	Fill Tracer Gross
99	SGS	Stabilize Tracer Gross
100	SI1	Setup - Sniffer Init
101	SI2	Setup - Sniffer Init 2
102	SLE	Tooling Seal Extend
103	SLR	Tooling Seal Retract
104	SME	Setup - Manifold Exhaust
105	SMF	Setup - Manifold Fill
106	SMI	Setup - Manifold Isolate
107	SNF	Sniffer Test
108	SNG	Sniffer Gross Test
109	SNW	Stabilize Tracer Wait
110	SPF	Fill Step
111	SPL	Setup - Pressure Select
112	SPR	Setup - Pre-Seq
113	SPS	Setup - Post-Seq
114	SSD	Stabilize Step Dwell
115	SSR	Setup - Set Regulator
116	STE	Stabilize Evac
117	STF	Stabilize for Flow
118	STG	General Stabilize
119	STR	Setup - Transducer Residual
120	STR	Stabilize Reference Volume

type "TABLE SEGMENT"

	Segment Code	Description
121	STS	Stabilize until Slope
122	SVD	Evac Test
123	SXT	Stabilize for Xdcr Test
124	TMC	Tooling Motion Control
125	XDR	Transducer Test

Test Data Identifier Codes

type "TABLE VARIABLE"

	Test Data Identifier Code	Description
1	%P	Percent Precision
2	2in	Two Inputs to Start
3	AAA	Accum Autozero
4	AAV	Accept Average
5	ACT	Auto-Cycle Test Mode
6	AD	Analog A/D
7	AER	Permit Early Reject
8	ALR	Alt Leak Rate
9	APC	Accept Percentage
10	APC	Atm Pressure Check
11	APP	Accept Program
12	AQ	Average Quantity
13	ARC	Autorun Cycle Count
14	ARE	Autorun Enable
15	ARM	Autorun Method
16	ARR	Autorun Relax
17	ASA	Short Autozero
18	ASD	Accept Std Dev
19	ASM	AutoSetup Method
20	ASP	Accept SPC Std Dev
21	ATD	Anti-Tie-Down
22	AZD	Autozero Delay
23	AZE	Autozero Enable
24	Ain	Analog Input
25	Aot	Analog Output
26	BC	Batch Calibration
27	BCM	Barcode Method
28	BL	Batch Layout
29	BQ	Batch Quantity
30	BR	Barcode Required
31	CA	Accept Cycles
32	CAP	Calibrate Percent
33	CC	Capability Code
34	CCD	Ch Evac Valve Dly
35	CCP	Clear Prog Counters
36	CCR	Clear Chan Results
37	CCS	Clear Chan Counters
38	CEF	Chmbr Evac Limit
39	CEV	Chmbr Evac Close
40	CFS	Cleanup Setpoint
41	CGP	Chmbr Pre-Purge
42	CGT	Chmbr Pre-Purge
43	CHM	Post-Purge Method
44	CHO	Chmbr Post-Purge
45	CHP	Chamber Pressure

	Test Data Identifier Code	Description
46	CHV	Chamber Volume
47	CID	CS Iso Delay
48	CLF	Corr. Leak Std Flow
49	CLM	Clamshell
50	CLP	Check Limit Percent
51	CLR	Cumulative Leak
52	CLR	Cal Required
53	CM	Cal Method
54	CM	Malfunction Cycles
55	CMN	Clean Min Pressure
56	CMP	Charge Min Press
57	CMX	Maximum Pressure
58	COF	Continue on Fail
59	COL	Cutoff Limit
60	CP	Current Precision
61	CPP	Copy Program
62	CPR	Charge Pressure
63	CPS	TLR Change/Sec
64	CPT	Consecutive Points
65	CPT	Consecutive Points
66	CR	Reject Cycles
67	CRA	Clean Part Source
68	CRF	Pre-Purge
69	CRS	Chmbr Crossover
70	CSC	Cycles Since Cal
71	CSN	Clear Since New Ctr
72	CSN	Cycles Since New
73	CST	Custom Self-Test
74	CT	Total Cycles
75	CTE	Continue to Evac
76	CTF	Continue to Fill
77	CTG	Target Pressure
78	CTP	Charge Target Press
79	CTP	Copy to Target Prog
80	CTR	Clean Part Timer
81	CTX	Continue T-Gas Exh
82	CXP	Charge Max Press
83	DA	Analog D/A
84	DD	Decay Direction
85	DFL	Direct Flow
86	DKL	DP Leak Loss
87	DL	Diff Press Loss
88	DLL	DP Master+Leak Loss
89	DLR	Diff Press Loss Rd
90	DLT	Delay Timer

type "TABLE VARIABLE"

	Test Data Identifier Code	Description
91	DML	DP Master Part Loss
92	DMR	DP Mstr Part Lss Rd
93	DP	Diff Pressure
94	DPI	DP iso Percent
95	DPP	¤ Press Precision
96	DVF	Vent During Fill
97	DVM	Test Mode
98	DVO	Device Mode
99	Dt	Date
100	ECL	ERC Crossover Limit
101	EDC	EDC Offset
102	EDE	EDC Enabled
103	EDP	EDC Percentage
104	EDP	Event ¤P
105	EDQ	EDC Quantity
106	EDT	Event ¤T
107	EIL	ERC Increment Limit
108	EM	Exhaust Method
109	EMP	Ext Xdcr Pressure
110	ENB	E-NOB
111	ENC	Enable Calibration
112	ENT	Enable Tooling I/O
113	EOL	ERC Offset Limit
114	EPP	Pressure Precision
115	EPR	Pressure Reference
116	EPV	Estimated Part Size
117	ERA	Atm Pressure
118	ERC	ERC Method
119	ERE	ERC Enabled
120	ERP	ERC Rate/Period
121	ERQ	ERC Quantity
122	ERR	E-Regulator Rest
123	ERV	Re-Evac After Test
124	ESC	Ext Switch Low Chk
125	ESN	External Sniffer
126	ESP	Exhaust Setpoint
127	ET	Elapsed Time
128	ETP	Evacuation Setpoint
129	ETP	Fine T-Gas Target
130	ETW	ERC Target Window
131	ETW	ERC Target Window
132	ETY	Edge Type
133	EUP	Pressure Unit
134	EVA	Evacuation Source
135	EVC	Eval Condition

	Test Data Identifier Code	Description
136	EVD	Vacuum Decay
137	EVL	Test Evaluation
138	EVM	Allow Evac Limit
139	EVP	Event Pressure
140	EVT	Event Type
141	EXD	Evacuation Xdcr
142	EXP	Execution Pause
143	FCC	Force Cal Cycles
144	FCD	FCal Date Limit
145	FCL	FCal Cyc Limit
146	FCM	Force Cal Mode
147	FCT	FCal Time Limit
148	FCT	Force Cal Time
149	FEL	Flow Event Limit
150	FL	Flow
151	FLD	Fine T-Gas Decay
152	FLF	Fine T-Gas Fill
153	FMV	Finish Mix Verify
154	FNB	FF-NOB
155	FP	Flow Precision
156	FPR	Fill Pressure
157	FPS	Fine Sample
158	FSW	Final Src Weight
159	FTA	Fill
160	FTA	Dwell
161	FTX	Test Failed Text
162	Fdb	Tooling Feedback
163	GLD	Gross T-Gas Decay
164	GLF	Gross T-Gas Fill
165	GLN	Gross T-Gas Min
166	GLT	Gross T-Gas Target
167	GLX	Gross T-Gas Max
168	GPS	Gross Sample
169	GPT	Gross Fill Pulse
170	HLE	High Limit Event
171	HLF	High Limit Flow
172	HLL	High Limit Loss
173	HLP	High Limit Pressure
174	HLQ	High Limit Leak
175	HLR	High Limit Rate
176	HLV	High Limit %Vref
177	I/O	I/O ID
178	IET	Event Type
179	IF	Instrument Flow
180	IIS	Input Initial State

type "TABLE VARIABLE"

	Test Data Identifier Code	Description
181	ILS	Level State
182	ILT	Level Time
183	IPR	Close Inner Purge
184	IS	Input State
185	ISO	Isolation
186	LAV	Leak Alarm Volume
187	LCD	Leak Std/Cal Define
188	LCD	Leak Std Cal Date
189	LCF	Correction Factor
190	LDP	Leak Det Precision
191	LDT	Dev Zero Delay
192	LDU	Leak Det Unit
193	LDZ	Device Zero
194	LF	Master+Leak Flow
195	LFC	Leak Std Cal Flow
196	LFR	Master+Leak Flow Rd
197	LIN	Linearity
198	LKF	Leak Flow
199	LKL	Leak Loss
200	LKM	Link Motion
201	LL	Master+Leak Loss
202	LLE	Low Limit Event
203	LLF	Low Limit Flow
204	LLL	Low Limit Loss
205	LLP	Low Limit Pressure
206	LLQ	Low Limit Leak
207	LLR	Master+Leak Loss Rd
208	LLR	Low Limit Rate
209	LLV	Low Limit %Vref
210	LMP	Link Motion Preempt
211	LNL	Linearity Limit
212	LOF	Loss Offset
213	LQ	Master+Leak QL
214	LQD	DP Mstr+Lk QL Rd
215	LQD	DP Master+Leak QL
216	LQF	Master+Leak QF Rd
217	LQF	Master+Leak QF
218	LQR	Master+Leak QL Rd
219	LR	Leak Rate
220	LRC	Leak Std Recert
221	LRO	Leak Rate Offset
222	LSC	Leak Std Chk
223	LSP	Leak Std Pressure
224	LSS	Leak Std Select
225	LSV	Leak Std Value

	Test Data Identifier Code	Description
226	LV	Launch Validation
227	ME	Malfunction Eval
228	MF	Master Part Flow
229	MFO	Manual Fill
230	MFR	Master Part Flow Rd
231	MFT	Manual Fill
232	ML	Master Part Loss
233	MLF	Min Mstr+Leak Flow
234	MLF	Min Leak Flow
235	MLL	Min Leak Loss
236	MLR	Master Part Loss Rd
237	MMF	Min Master Flow
238	MMF	Min Master Flow
239	MML	Max Master Loss
240	MML	Min Mstr+Leak Loss
241	MML	Min Master Loss
242	MNT	Min Tare Weight
243	MO	Master Flow Offset
244	MOR	Master Flow Offset
245	MPC	Malfunction Percent
246	MPF	Min Perform Factor
247	MPP	Max System Pressure
248	MQ	Master Part QL
249	MQD	DP Mstr Part QL Rd
250	MQD	DP Master Part QL
251	MQF	Master Part QF Rd
252	MQF	Master Part QF
253	MQR	Master Part QL Rd
254	MSL	Reject Rate
255	MSO	MS Iso Open Delay
256	MSP	Max Pressure - Opt
257	MSR	Mark Severe Lk Rej
258	MST	Mass Spec Purge
259	MTM	Min T-Gas Mode
260	MTS	T-Gas Source
261	MV	T-Gas Mix Verify
262	MVF	T-Gas Tgt Press
263	MVH	Leakrate High Limit
264	MVL	Leakrate Low Limit
265	MVM	T-Gas Leak Rate
266	MVS	Start Mix Verify
267	MVT	T-Gas Fill Timer
268	MXT	Max Tare Weight
269	Mot	Motion Number
270	Mot	Number of Motions

type "TABLE VARIABLE"

	Test Data Identifier Code	Description
271	NAM	Program Name
272	NBC	Number of Barcodes
273	NLK	Number of Links
274	NOP	Number of Options
275	NPP	Next Program
276	NPS	Number of Steps
277	NTP	Sample Points
278	NUM	Number of Programs
279	OLS	Open Leak Std
280	OPT	Option
281	OTL	Open T-Gas Leak Std
282	P	Master Gauge Press
283	P	Instrument Pressure
284	P	Meas Pressure
285	P%V	Part %Vref
286	PC	Pneumatic Code
287	PCL	Leak Std Cal Press
288	PCR	Pressure Correction
289	PCT	Chmbr Post-Purge
290	PDL	Press Delta Limit
291	PET	Part Evac Limit
292	PEV	Part Evacuation
293	PEX	Partial Exhaust
294	PF	Performance Factor
295	PFL	Part Flow
296	PFM	Prefill Method
297	PG	Target Pressure
298	PKP	Peak Pressure
299	PL	Pressure Loss
300	PLP	Predicted Loss
301	PLQ	Master+Leak Q-Press
302	PLR	Pressure Loss Rd
303	PLR	DP Mstr+Lk Loss Rd
304	PM	Master Part Press
305	PM	Part Mark
306	PMF	Part Mark Feedback
307	PML	Master+Leak Press
308	PMN	Minimum Pressure
309	PMQ	Master Part Q-Press
310	PMX	Maximum Pressure
311	PNM	Sniffer Test Point
312	PP	Pressure Precision
313	PP	Proof Pressure
314	PPC	Part Present Check
315	PPC	Prefill Press Check

	Test Data Identifier Code	Description
316	PPE	Pre-Press Enable
317	PPR	Pre-Pressure
318	PPS	Pre-Press Select
319	PPW	Pre-Pressure Window
320	PQ	Predicted Leak
321	PRF	Prefill
322	PRI	Programmable Input
323	PRO	Programmable Output
324	PRR	Pressure Restrict
325	PSL	Pressure Select
326	PSL	Pressure Select
327	PSL	Pressure Select
328	PSP	Setpoint Pressure
329	PST	Self-Test Pressure
330	PSV	Part Sniffer Type
331	PT	Target Pressure
332	PTF	Prefill
333	PTG	Gross Prefill
334	PTP	¤P/¤T Precision
335	PTS	Port Select
336	PTS	Part Seal
337	PTU	¤P/¤T Unit
338	PTX	Test Passed Text
339	PW	Weight Precision
340	Pp	Part Pressure
341	Pr	Ref Pressure
342	Ps	Standard Pressure
343	Pt	Program Number
344	Pt	Test Pressure
345	Pt	Target Pressure
346	Pt	Apply to Program #
347	QF	Quik Flow
348	QHL	Quik Test HL Band
349	QL	Quik Loss
350	QLL	Quik Test LL Band
351	QP	Quik Test Pressure
352	QPT	Quantity Points
353	QTE	Quik Test Enable
354	RAN	Number of Points
355	RAP	Analysis Pressure
356	RAS	Analysis Voltage
357	RAT	Analysis Percent
358	RAV	Reject Average
359	RC	Elec Regulator Cal
360	RC1	EReg Zero DA Cal

type "TABLE VARIABLE"

	Test Data Identifier Code	Description
361	RC2	EReg Span DA Cal
362	RC3	EReg Zero Base Cal
363	RC4	EReg Span Base Cal
364	RCA	Analog Value
365	RCD	Last Cal Date
366	RCI	Instrument Pressure
367	RCP	Retention Cutoff
368	RCS	Setpoint Voltage
369	RCT	Last Cal Time
370	RCV	Master Value
371	RDI	Restore Default I/O
372	RDT	Reg Dwell Timer
373	RED	Refrgnt Vent Close
374	REG	Regulator
375	REO	Refrigerant Vent
376	REX	Refrigerant Vent
377	RFC	Fill Close Delay
378	RFL	Reference Loss
379	RL	Loss Rate
380	RLC	Run Leak Calibrate
381	RLR	Loss Rate Rd
382	RLV	T-Gas LeakStd Value
383	RMX	EReg Span DA Cal
384	RNP	Number of Points
385	ROS	Reject on Slope
386	RPC	Reject Percentage
387	RPM	Ramp Method
388	RPP	Retain Part Press
389	RPP	Reject Program
390	RR	Ramp Rate
391	RR	Retract on Reject
392	RRT	Reject Rate Total
393	RSI	Result Information
394	RSP	Slope Window
395	RSR	Slope Change/Sec
396	RST	Stabilize
397	RVH	High Limit Voltage
398	RVH	High Limit Voltage
399	RVL	Low Limit Voltage
400	RVL	Low Limit Voltage
401	RVP	Retain Volume Press
402	RXM	Pre-Evac Exhaust
403	SAM	Sample Size
404	SAS	Start AutoSetup
405	SCF	Cal Coefficient

	Test Data Identifier Code	Description
406	SCL	T-Gas LeakStd Value
407	SCO	Cal Offset
408	SCP	Start Clean Part
409	SCR	Reject Rate Percent
410	SCT	Scale Type
411	SDH	ST DP High Limit
412	SDL	ST DP Low Limit
413	SEV	Leak Rate Window
414	SF	Standard Flow
415	SGN	Sample Gas Number
416	SIO	Sniffer Init
417	SMP	Sample Time
418	SN	Step Number
419	SNR	SNR
420	SOD	Shut Off Delay
421	SP	Standard Pressure
422	SP	Starting Pressure
423	SPM	Fine Wait
424	SPT	Gross Wait
425	SR	Set Regulator
426	SRC	Start Calibration
427	SRH	LD Leak Val Max
428	SRH	ST RPL High Limit
429	SRL	ST RPL Low Limit
430	SRL	LD Leak Val Min
431	SSW	Starting Src Weight
432	STH	ST TPL High Limit
433	STL	ST TPL Low Limit
434	STL	Self-Test Level
435	STM	Self-Test Method
436	STN	Self-Test Program
437	STP	Target Press
438	STS	Self-Test Source
439	STS	Start Self-Test
440	STT	Self-Test Limit
441	STV	Step Target Press
442	STW	Target Window
443	SXC	Start Calibration
444	SXT	Start Xdcr Test
445	SXV	Start Verification
446	SZH	LD Zero Val Max
447	SZL	LD Zero Val Min
448	Ser	Serial Number
449	Stn	Channel Number
450	T	Timer

type "TABLE VARIABLE"

	Test Data Identifier Code	Description
451	T	Timer
452	TBF	LD Background Limit
453	TEP	T-Gas Exh Press
454	TI	Iso Delay Timer
455	TL	Tooling Option
456	TLK	Test Leak Rate
457	TLP	Leak Rate Precision
458	TLR	T-Gas Leak Rate
459	TLU	Leak Rate Unit
460	TML	LD Min T-Gas Setpt
461	TMN	Fine T-Gas Min
462	TMP	Temp Precision
463	TMX	Fine T-Gas Max
464	TP	Time Precision
465	TPP	Target Program
466	TPW	Target Press Window
467	TQ	Quik Test Timer
468	TR1	Trigger 1
469	TRA	T-Gas Source
470	TRM	T-Gas Recovery
471	TSM	T-Gas Sampling
472	TT	Test Sel Timer
473	TT	Test Execution Time
474	TTF	TracerMate Flags
475	TTY	Test Type
476	TTY	Test Type
477	TV	Valve Delay Timer
478	TW	Target Weight
479	TWN	Min Fill Weight
480	TWX	Max Fill Weight
481	Tcy	Desired Cycle Time
482	Tm	Timer Mode
483	Tm	Time
484	UC	Current Unit
485	UDP	¤ Pressure Unit
486	UF	Flow Unit
487	UP	Pressure Unit
488	UP	Percent Unit
489	UPD	Unit/Prec Define
490	UT	Time Unit
491	UTM	Temperature Unit
492	UV	Voltage Unit
493	UV	Volume Unit
494	UW	Weight Unit
495	V	V

	Test Data Identifier Code	Description
496	VAN	Valve A Num - Opt
497	VAP	Valve A PWM - Opt
498	VAT	Valve A Type - Opt
499	VBN	Valve B Num - Opt
500	VBP	Valve B PWM - Opt
501	VBT	Valve B Type - Opt
502	VC	Valve Code
503	VCN	Valve C Num - Opt
504	VCP	Valve C PWM - Opt
505	VCT	Valve C Type - Opt
506	VDN	Valve D Num - Opt
507	VDP	Valve D PWM - Opt
508	VDT	Valve D Type - Opt
509	VFL	Virtual Flow
510	VHT	Vent/Halt Tooling
511	VLD	Valve Detection
512	VLP	Volume Precision
513	VLV	Valve Number
514	VNP	Number of Points
515	VP	Voltage Precision
516	VPS	Setpoint Pressure
517	VPW	Valve PWM
518	VSP	Setpoint Voltage
519	VWO	Residual Offset
520	Vi	Instrument Volume
521	Vp	Part Volume
522	WGT	Refrigerant Weight
523	WHL	High Limit
524	WIN	Stat History Length
525	WLL	Low Limit
526	XAN	Xdcr Zero LL
527	XAX	Xdcr Base Max
528	XBH	Xdcr Zero Hwin
529	XBL	Xdcr Zero Lwin
530	XC	Transducer Cal
531	XC1	Xdcr Zero AD Cal
532	XC2	Xdcr Span AD Cal
533	XC3	Xdcr Zero Base Cal
534	XC4	Xdcr Span Base Cal
535	XCA	Analog Value
536	XCB	Atm Pressure
537	XCD	Last Cal Date
538	XCF	Instrument Flow
539	XCI	Instrument Pressure
540	XCL	Xdcr Curr Limit

type "TABLE VARIABLE"

	Test Data Identifier Code	Description
541	XCM	Master Reading
542	XCP	Cal Pressure
543	XCS	Setpoint Pressure
544	XCT	Last Cal Time
545	XCV	Master Value
546	XCX	Xdcr Cal X Array
547	XCY	Xdcr Cal Y Array
548	XFC	Xdcr Filter Code
549	XFP	Flow Precision
550	XID	Xdcr Iso Delay
551	XIS	Xdcr Span Inter Cal
552	XIZ	Xdcr Zero Inter Cal
553	XLF	Max Mstr+Leak Flow
554	XLF	Max Leak Flow
555	XLL	Max Leak Loss
556	XMF	Max Master Flow
557	XML	Max Mstr+Leak Loss
558	XMN	Xdcr Base Min
559	XMX	Xdcr Base Max
560	XNP	Number of Points
561	XOP	Crossover Pressure
562	XPC	Pressure Correction
563	XPM	Pressure Mode
564	XPP	Pressure Precision
565	XPR	Pressure Reference
566	XRL	Xdcr Residual Limit
567	XRW	Xdcr Residual Warn
568	XSP	Setpoint Pressure
569	XT	Transducer
570	XT	Xdcr Tare
571	XTG	Xdcr Tare Range
572	XTR	Xdcr Typ Residual
573	XUF	Flow Unit
574	XUP	Pressure Unit
575	XV	Transducer Verify
576	XVD	Verify Date
577	XVF	Instrument Flow
578	XVI	Instrument Pressure
579	XVM	Master Reading
580	XVS	Setpoint Pressure
581	XVT	Verify Time
582	XVV	Master Value
583	XZC	Xdcr Zero Check
584	XZH	Xdcr Zero HL
585	XZL	Xdcr Zero LL
586	XZW	Xdcr Zero Window
587	t	Test Time

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Sentinel MH Specifications

Technical Specifications

Housing: (HxWxD) 165 x 90 x 215 mm (6.5 x 3.5 x 8.5 in) See Mounting and Clearance Diagrams
Electrical: 24 VDC +/- 1% 1.5 Amps
Air Quality: ISO 8573-1:2010 [2:2:2] Compressed air or nitrogen only
Pressure Regulation: External (customer supplied) or Internal Electronic regulator
Test Pressure: Vacuum – 200 psig
Pilot Pressure: 55 - 70 psig (3.8 – 4.8 bar)
Operating Temperature: 41-104° F (5-40° C)
Operating Humidity: 90% non-condensing
Weight: 2.2kg (4.9 lbs)

Test Capabilities

Differential Pressure/Vacuum Decay - ΔP
Differential Pressure/Vacuum Decay - ΔP/ΔT
Differential Pressure/Vacuum Decay - Leak Standard
Differential Pressure/Vacuum Decay - Leak Rate
Occlusion (Back pressure)

Interfaces

Communication via RS232, TCP/IP (Telnet), and EtherNet/IP™
Tooling control for simple applications
I/O: 7 discrete inputs, 5 discrete outputs

Measurement Characteristics

Measurement Accuracy* ±0.006 % FS
Measurement Resolution 0.000001 Δpsi
Leak Rate Resolution 0.00005 sccm

Options

Electronic regulator
Multiple pressure ranges
External leak standard port

Accessories

Calibrated leak standard
CTS Connects
Calibrated adjustable leak simulator
Filter kit

Contact Cincinnati Test Systems Customer Service Department

By phone 513-202-5108 or by email service@cincinnati-test.com 8am-5pm eastern US

For after-hours, 24/7 emergency phone support, call 513-202-5174