
# *Sentinel I28, C28, A28, LPC528, MH, & Blackbelt Communications Guide*

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# Introduction

## Overview

The Cincinnati Test Systems Sentinel product line are high-precision leak test instruments which features a serial RS-232 DB9 connector and an RJ45 Ethernet port for communication with a machine control system. The Sentinel instruments communicate via the Telnet protocol with an underlying TCP/IP transport mechanism. It is the goal of this guide to explore the communication protocol and available commands to be able to successfully control and configure a Sentinel instrument in a control system. The Sentinel instruments that this guide covers include the I28, C28, A28, LPC528, MH, and Blackbelt.

Many of the operations available via the user interface can also be performed via communications. This document details functionality and provides various examples to reference.

Throughout this document you will text see displayed in green font, representing **direct writes to** and reads from the Sentinel instrument. A write command is prefaced with the character (' **>** '). This character NEVER needs to be written to the Sentinel instrument. In fact, writing it to the instrument will result in an error.

***IMPORTANT:***

***All instrument commands and parameter writes in this manual are referenced in standard text form for ease of readability. However, when actually sending a command to the instrument over Telnet, it will need to be ASCII literal code, followed by a carriage return and line feed. For example, when this document instructs you to send the following:***

```
> P1\X\Test Type=Pressure Decay-Leak Std
```

***The ASCII string that should be sent to the instrument MAY actually be:***

```
> P1\\X\\Test\sType=Pressure\sDecay\s-\sLeak\sStd\r\n
```

***Note the use of ASCII codes with the escape character '\' to denote spaces, carriage return and line feed.***

***Double-check how your API or run-time environment formats ASCII string commands in order to ensure that you have input the correct syntax.***

## Interface Connections

The Sentinel instruments feature the following ports:

- (1 or 2) RS-232 Serial DB9 connector
- (1) RJ45 Ethernet port
- USB port supports only FAT32 USB flash drives, not serial communication

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# Chapter 1 – Communication Interfaces

Below is the list of available communication Interfaces in Sentinel instruments.

| Sentinel Instrument | RS232 1 | RS232 2 | Telnet (TCP/IP) | Ethernet/IP | USB (Storage) |
|---|---|---|---|---|---|
| I28 | ✓ | ✓ | ✓ | ✓ | ✓ |
| C28 | ✓ | × | ✓ | ✓ | ✓ |
| A28 | ✓ | × | ✓ | ✓ | ✓ |
| LPC528 | ✓ | × | ✓ | ✓ | ✓ |
| MH | ✓ | × | ✓ | × | ✓ |
| Blackbelt | ✓ | × | ✓ | ✓ | ✓ |

**Note**: Communication interfaces are only available in the English language. The language cannot be changed via the communication interface., The language can be changed only via the User Interface menu.

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# Chapter 2 – Communication Overview

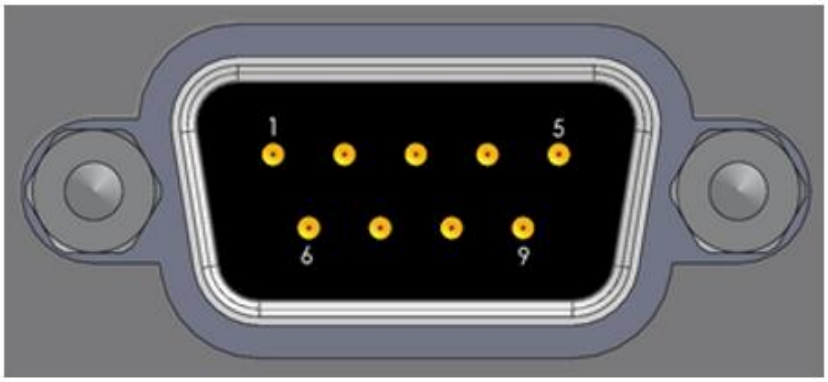
## Instrument Communication

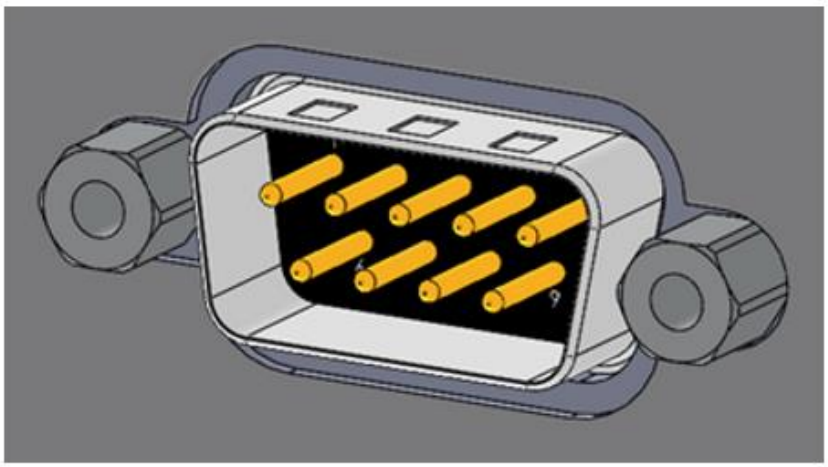
The Sentinel instrument is able to communicate over RS-232 and/or Ethernet via Telnet. This chapter explains how to setup communications. The commands in this chapter work with either method of communication. Refer to Appendix C – Terminal Emulator Software Configuration to see example configurations for a variety of terminal emulators that can be configured to communicate with the Sentinel instrument.

The communication parameters are located in **Main Menu > Global Config** icon.

## Establishing RS-232 Communication

The pinout for the RS232 connector 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 |

The RS-232 parameters are located in **Main Menu > Global Config > RS232 1** or **RS232 2.** The first step in establishing RS-232 communication with the instrument is to set the RS232 1 or RS232 2 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 TCP/IP 1 communication port. This setting is located in the **Main Menu > Global Config > RS232 1** icon > **RS232 1 Echo** or **Main Menu > Global Config > RS232 2** icon **> RS232 2 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.

***Note: The Sentinel I28 is the only instrument to support two RS-232 ports.***

## 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). The Sentinel instrument is shipped with a default setting of DHCP, to acquire network settings from an Ethernet router. 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 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** icon. 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.

A Telnet session with the instrument can be established by connecting to its IP address over port 23. A successful connection to the Sentinel via Telnet will offer an interface menu. The instrument will return:

```
************************************************************************
* TCP/IP INTERFACE SELECTION *
************************************************************************
*
*Select from the following available connections..enter connection number
* 1 Interface Connection1 *
* 2 Interface Connection2 *
* 3 Interface Connection3 *
* 4 Interface Connection4 *
```

The Sentinel can handle up to 4 separate interfaces concurrently, with the caveat that only one interface at a time can handle streaming data. Interface Connection 1 is used in the example below. Successful selection of an interface will result in the Sentinel returning an acknowledgement of the interface selected.

```
> 1

* Interface Connection 1 has been established *
```

***Note: For the purposes of communication, after an interface has been selected, all frames returned from the Sentinel starting with an * (asterisks) can be safely ignored.***

***Note: Once a connection has been established, it can persist for the lifetime of the machine application. Any network disruptions may cause loss of communications and force a reestablishment of the Telnet session.***

## 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 the Data Type Code Table below.) |
| | Tab |

### Table of Data Type or Header Codes

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

## Menu Structure and Read/Write

The CTS instrument consists of a menu system to be able to read and write parameters. The menus are nested two deep with a variable attached. All variables will be found in the form:

```
> Menu 1\Menu 2\Variable Name = Value
```

Reading a variable is as simple as calling the variable and waiting for a response from the instrument. For example, to read the value of the Program 1 Fill Timer, you would write:

```
> P1\R\Fill
```

The Sentinel would then respond as:

```
AE11006 P1\R\Fill=2.00 sec f
```

To write a new value to a variable, simply append an equal sign followed by a value to the variable. For example, to change the Program 1 Fill Timer to 3 seconds, you would write:

```
> P1\R\Fill=3.00
```

The Sentinel will always reply to a well-formed variable with a response. It will always echo back what is currently written in the flash memory of the Sentinel. In this case, the Sentinel will respond with:

```
351202F P1\R\Fill=3.00 sec f
```

This indicates that the value was written successfully to 3.00 seconds.

In some cases, the instrument will prompt you for an action when attempting to run some functionality. An example of this is shown below:

```
DC00062 P  SET REGULATOR - Insert Self-Test cap into test port.
Select OK to continue, or CANCEL to quit.
```

Notice that the instrument's response begins with the header "**DC00062 P**". The Data Type Code "**P**" indicates that the instrument has prompted you for an action. Responding to this prompt will require the use of a menu command.

## Controlling the Instrument

The Sentinel instrument can be instructed to Start, Stop, and Calibrate a program. The Sentinel instrument can only have one Current Active Program (CAP) available at a time to control. The CAP can be found using the command:

```
> M\S1TCAP
880400E V01: MS1TCAP=1
```

In this example, the CAP is program 1. Sending a Start, Stop, or Calibrate command to the Sentinel instrument would act on program 1. Below are the control commands followed by the response from the Sentinel, as an example.

```
> M\S1TStart
5000016 M01: Start Test-S01P02
> M\S1TAutoCal
BF05019 M01: Start AutoCal-S01P02
> M\S1TStop
* Station Stopped
```

Here we see the commands followed by the response from the instrument. The response gives information about whether a test/calibration has started and which station and program is currently running. Stopping a test gives a message back alerting the user that the Sentinel has stopped. If streaming data is turned on, after a test has started, the instrument will start streaming measured data for the duration of the test. The Sentinel will return results after a test has run. Refer to Chapter 5 – Test and Result Data for more information.

### Table of General Instrument Control Commands

| Example Command | Description |
|---|---|
| **M\S1TCAP** | Reads the Currently Active Program. |
| **M\S1TCAP=#** | Changes the Currently Active Program to Program #. |
| **M\S1TStart** | Starts testing the Currently Active Program. |
| **M\S1TStop** | Stops a currently running test. |
| **M\S1TAutoCal** | Begins an Auto-Calibration sequence on the Currently Active Program. |

## Table of General Menu Control Commands.

| Example Command | Description |
|---|---|
| **EXIT** | Exits out of the current menu level. If the instrument is not recognizing commands, you may have navigated into a nested menu. Sending an EXIT command will bring you back to the root menu from which all commands should be run. |
| **KEY ENTER** | Simulates an OK button when prompted for an action. |
| **KEY EXIT** | Simulates a CANCEL button when prompted for an action. |
| **KEY MENU** | Simulates a MENU button when prompted for an action |
| **KEY UP** | Simulates a UP button when prompted for an action |
| **KEY DOWN** | Simulates a DOWN button when prompted for an action |
| **KEY LEFT** | Simulates a LEFT button when prompted for an action |
| **KEY RIGHT** | Simulates a RIGHT button when prompted for an action |
| **KEY HELP** | Simulates a HELP button when prompted for an action |
| **KEY USB** | Simulates a USB button when prompted for an action |
| **KEY START** | Simulates a START button when prompted for an action |
| **KEY STOP** | Simulates a STOP button when prompted for an action |

***Note1: If a prompt is left unanswered with either a KEY ENTER or KEY EXIT, further commands or prompts may unknowingly begin to stack up in the instrument RAM. In this situation a power cycle may be required to clear the memory.***

Throughout this document there are example commands given for different variables in the instrument setup. For the sake of space and to eliminate redundancy, the instrument's response is usually not included with the example, unless it is specifically needed.

**Warning 1**: The KEY commands can only be used for the purpose of user interface and not for the purpose of communication query and control. These KEY commands must be used only to simulate physical key functionality present on the instrument.

**Warning 2:** KEY command should not be used as standard test control operation command, i.e. test change operation etc. For this purpose, the user can use standard test commands, as mentioned in the Chapter 2, "controlling the instrument".

**Warning 3:** The KEY command does not provide any acknowledgment so while using KEY command user must aware about the instrument and user interface state. Without knowing the instrument state, it is not advisable to use KEY command because this may cause inappropriate operation.

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# Chapter 3 – Setup

## Global Configuration

### Network Settings

All Sentinel instruments ship from the manufacturer set to request IP parameters from a network server using DHCP. If it is necessary for your application to change these addresses, the configuration can be done with the following commands:

```
> I\T\Obtain Network Settings=Manual
> I\T\Instrument IP Address=169.254.0.77
> I\T\Subnet Mask=255.255.0.0
> I\T\Gateway IP Address=169.254.0.1
```

Setting the first parameter above to Manual tells the instrument that it will have a static IP address, which is then set with the second command. However, the instrument can also be configured to obtain an address dynamically from a switch or router by changing the first parameter to DHCP instead of Manual:

```
> I\T\Obtain Network Settings=DHCP
```

*Note: Changing network settings over an active Telnet session may require you to power cycle the instrument or re-establish the Telnet connection.*

### Miscellaneous Settings

If desired, each instrument can be given a unique name to more easily identify it.

```
> I\M\Instrument Name=CTS I281
```

The instrument's internal date and time settings can also be reconfigured if your location is different from the time zone set at the factory.

```
> I\M\Date Format=MM/DD/YY
> I\M\Date=10/28/15
> I\M\Time=04:12:18
```

## 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 unit of measure, you can set the units in one place and have them apply instrument wide. This is done in the Channel Configuration menu.

| COMMAND | VARIABLE OPTIONS |
|---|---|
| **C\U\Time Unit** | =hour, min, sec, msec |
| **C\U\Time Precision** | =X.X, X.XX, …, X.XXXXXX |
| **C\U\Pressure Unit** | =psig, psiv, iWC, cmWC, mmWC, inHg, cmHg, mmHg, Pa, kPa, MPa, ksc, atm, bar, mbar, Torr |
| **C\U\Pressure Precision** | =X.X, X.XX, …, X.XXXXXX |
| **C\U\d Pressure Unit** | =dpsig, dpsiv, diWC, dcmWC, dmmWC, dinHg, dcmHg, dmmHg, dPa, dkPa, dMPa, dksd, datm, dbar, dmbar, dTorr |
| **C\U\d Pressure Precision** | =X.X, X.XX, …, X.XXXXXX |
| **C\U\dP/dT Unit** | =bar/s, psi/s, iWC/s, cWC/s, mWC/s, iHg/s, cHg/s, mHg/s, pa/s, kPa/s, MPa/s, ksd/s, atm/s, bar/s, mb/s |
| **C\U\dP/dT Precision** | =X.X, X.XX, …, X.XXXXXX |
| **C\U\Flow Unit** | =sccm, sccs, scch, slpm, slps, slph, scfm, scfs, scfh |
| **C\U\Flow Precision** | =X.X, X.XX, …, X.XXXXXX |
| **C\U\Volume Unit** | =cc, Cin, Gal, L, ML |
| **C\U\Volume Precision** | =X.X, X.XX, …, X.XXXXXX |
| **C\U\Percent Unit** | =% |
| **C\U\Percent Precision** | =X.X, X.XX, …, X.XXXXXX |

***Note: The units set on the Channel Config are also the units used for Self-Test and Auto Setup (where applicable).***

## Setting the Leak Standard Values

The instrument has the capability to utilize a different leak standard for each configured program that uses a leak standard. Alternatively, the instrument also has the capability to use the same leak standard for all programs. If you always use the same leak standard, you can set the leak standard value and pressure in one place and have it apply 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: Change the Leak Std/Cal Define parameter to "Channel". Set the leak standard value and the pressure at which it was calibrated. This leak standard value will apply to every program that utilizes a leak standard for calibration.**

```
> C\L\Leak Std/Cal Define=Channel

> C\L\Leak Std Cal Flow=0.13 sccm
> C\L\Leak Std Cal Press=1.00 bar
```

**No: Change the Leak Std/Cal Define parameter to "Program". The leak standard parameters will now be available 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.**

```
> C\L\Leak Std/Cal Define=Program

> P1\S\Leak Std Cal Flow=0.35 sccm
> P1\S\Leak Std Cal Press=2.00 bar
```

*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.*

### Setting the Pneumatic Regulator

Setting the regulator is done by plugging the instrument test port and adjusting the manual regulator until the pressure reads the desired value. If the test port is not plugged, the instrument will be unable to build pressure and the readings will not be accurate. To start the Set Regulator function in the instrument, send the Set Regulator command.

```
> C\P\Set Regulator=Yes
```

The instrument will respond as below.

```
DC00062 P SET REGULATOR – Insert Self-Test cap into test
port. Select OK to continue, or CANCEL to quit.
```

Send a KEY ENTER command to start the instrument. Alternatively, send a KEY EXIT command to cancel. The instrument will stream pressure readings as you manually adjust the regulator to the desired pressure. Refer to Chapter 5 – Test and Result Data for a better understanding of streamed data. Send a STOP command when finished to stop the instrument.

```
> KEY ENTER
…
…
…
> M\S1TStop
```

## Selection of Test Types

In order to setup a leak test, you will first select the type of test you would like to conduct via the pre-packaged test sequences. Table of Test Type Selection Options on the following pages includes all of the different test types available in the Sentinel instruments, and a brief description that details each test type. Not all of the test types are available in all Sentinel instruments. Some test types will not apply to the instrument you are using. Three common test types are described in more detail in the following three chapters.

Once you determine which test type is appropriate for your application, first select the program you would like to configure using the Current Active Program command.

```
> M\S1TCAP=1
```

Then set the program type using the Program Test Type command.

```
> P1\X\Test Type=Pressure Decay-Leak Std
```

If desired, the program can also be given a name as a descriptor.

```
> P1\M\Program Name=Part A
```

## Table of Test Type Selection Options

Sample commands are shown with **bold green font**.

| Test Type | Description |
|---|---|
| Pressure Decay-ΔP<br>Pressure Decay ΔP<br>**P1\X\Test Type=Pressure Decay–dP** | Measures the Pressure Loss (ΔP) 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. |
| Pressure Decay-ΔP/ΔT<br>**P1\X\Test Type=Pressure Decay–dPdt** | Measures the Pressure Loss (ΔP/ΔT) over unit time. Determined from the pressure loss over the duration of the test timer divided by the test time. The result is presented in units of delta pressure over delta time. |
| Pressure Decay-Leak Std<br>Pressure Decay-Leak Std<br>**P1\X\Test Type=Pressure Decay–Leak Std** | Calculates the Leak Rate, based on pressure loss. Determined from the pressure loss over the duration of the test timer relating to the pressure loss of the leak standard and of the non-leaking master part. The result is presented in units of flow. |
| Differential Pressure Decay Leak Std<br>Diff Pressure (DP) Decay-Leak Std<br>**P1\X\Test Type=**<br>**Diff Pressure Decay–Leak Std** | 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 master part. The result is presented in units of flow. |
| Occlusion<br>**P1\X\Test Type=Occlusion** | 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. |
| Pressure Verify<br>**P1\X\Test Type=Pressure Verify** | Measures the Pressure at the isolated test port (no fill). Determined from the pressure at the end of the Test segment timer. The result is presented in units of pressure. |
| Mass Flow<br>**P1\X\Test Type=Mass Flow** | Measures the Mass Flow needed to maintain the part at a set pressure. Typically used in applications where flow is expected. The result is presented in units of flow. |

| Test Type | Description |
|---|---|
| Mass Flow-Leak Std<br>**P1\X\Test Type=Mass Flow–Leak Std** | Measures the Mass Flow needed to maintain the part at a set pressure. Typically used in low leak applications. The result is presented in units of flow. |
| Ramp to ΔP Event<br>**P1\X\Test Type=Ramp to dP Event** | Measures the peak pressure before a Pressure Loss (ΔP) Event. Determines the maximum pressure before the pressure loss limit is exceeded as well as records the duration of time before the event. The results are presented in units of pressure and time. |
| Ramp to Input Event<br>**P1\X\Test Type=Ramp to Input Event** | Measures the pressure at an Input Event. During test pressure ramp, monitors for trigger event on a digital input, then determines the pressure as well as records the duration of time before the event. The results are presented in units of pressure and time. |
| Ramp to Flow Event<br>**P1\X\Test Type=Ramp to Flow Event** | Primarily used for testing the cracking point of a check valve. Measures the point at which the flow crosses a threshold. Determines the maximum pressure before the Flow Event limit is exceeded as well as records the duration of time before the event. The results are presented in units of pressure and time. |
| Ramp to Proof Test<br>**P1\X\Test Type=Ramp to Proof** | Designed to make sure component can hold a pressure for a fixed period of time. Result determined from the maximum pressure during the test and duration of the test timer. The result is presented in units of pressure. |
| Parent Program Linking<br>**P1\X\Test Type=Parent Program Linking** | Facilitates linking individual programs into a single test sequence for conducting multiple tests on one part or one part with multiple chambers. Contains tooling control parameters and link definitions. Each link defines the target program to execute and evaluation conditions for additional program execution. |

### Setting the Test Parameters

It is time to set the test parameters to fit your application. If the test type for your application is not one of the three sample test types covered in Chapter 3, please refer to the user manual for your Sentinel instrument for more information on setting parameters.

**Note:** *During execution, the Program/Channel configuration parameters cannot be edited via communication interfaces.*

### 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 quickly 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.

To run a Self-Test, first specify the pressure setting of the pressure source, then send a Start Self-Test command and a KEY ENTER command to accept the prompt. Alternatively, send a KEY EXIT command to cancel.

```
> C\S\Self Test Pressure=1.00 bar
> C\S\Start Self Test=Yes

EE0205E P SELF TEST - Insert Self-Test cap into test port.
Select OK to continue, or CANCEL to quit.

> KEY ENTER
```

When finished, the instrument will output the evaluation result of the test. Refer to Chapter 5 – Test and Result Data for a better understanding of streamed data. Once the test completes and a final result is returned, send a KEY ENTER command to exit the Self-Test function.

```
> KEY ENTER
```

## Security

The as-shipped security mode of the instrument is set to use a password ("5555" by default) to unlock secure functionality in the instrument web page. It is recommended that this password be changed through the Security Menu. To access the instrument Security Menu, you must first enable viewing it:

```
> I\M\Edit / View Security=On
```

The password can now be changed with the following command format:

```
> I\X\Change Password=<New Password> <Old Password>
```

For example, to change the password from "5555" to "1234", you would send:

```
> I\X\Change Password=1234 5555
```

Remember to write down the new password. If the new password is forgotten, Cincinnati Test Systems can provide a back door password that changes every hour.

### Parameter edit with security turned ON:

To override security while editing the variables of Global, Channel or Program config when respective security feature is enabled, user needs to send the command "*variable=x PASSWORD*" via communication interface. However, it doesn't disable the security for the user interface, and while editing variable via user interface, the user will be required to enter user password.

For example, to edit RS232 1 streaming from the Global config->RS232, you would send:

```
> I\S\RS232 1 Streaming=ON 5555
```

To edit Number of Programs from the Channel config->MISC, you would send:

```
> C\M\Number of Programs=12 5555
```

To edit Target pressure variable from the Program config->Program 1->Pressure, you would send:

```
> P1\P\Target Pressure=50 5555
```

## 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.

## Barcode

The instrument has the capability to store barcode data with each test result. The instrument will work with any RS232 barcode scanner that has the ability to supply a barcode in an ASCII string (no longer than 40 characters*) followed by a carriage return.

To edit Barcode, you would send:

```
> Barcode=TST123456
```

Another method to enter Barcode:
The Barcode function is located in Global Config->RS232->RS232 Interface. Set the parameter to "Barcode". Now to edit Barcode, you would send:

```
> TST123456
```

***Note: If you want instrument to support larger barcode string length (up to 80 characters), please contact CTS service.***

***Note: Barcode feature only supported in Blackbelt and I28 instruments.***

# Chapter 4 – Test Configuration

*The following 3 sections of this guide provide configuration examples for some of the various test types available in the Sentinel product line. Your instrument may have addition test types that are not listed in this chapter. Refer to the user manual provided with your instrument for detailed descriptions of each test parameter.*

## Pressure Decay ΔP

*This section explains the parameters for conducting a pressure decay test measuring a pressure loss over time. 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.*

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.

### Timer Parameters

| Timer | Description | Example Setting |
|---|---|---|
| Prefill<br>**P1\R\Prefill** | Checks for excessively leaking parts or lack of pressure. Set as a % of fill time, for fixed fill time tests. Maximum time to reach the minimum pressure. | =50% |
| Fill<br>**P1\R\Fill** | Time to enable part to reach the Target Pressure. It may also be used as time to stabilize part pressure with additional air. | =2.00 |
| Stabilize<br>**P1\R\Stabilize** | Time to stabilize part pressure while isolated from the pressure regulator. This time directly affects the repeatability of the test. | =5.00 |
| Test<br>**P1\R\Test** | The precise time over which to measure pressure drop or decay or the precise end time to measure pressure rise. | =10.00 |
| Exhaust<br>**P1\R\Exhaust** | Time to relieve or vent part pressure before signaling the end of test. Need time to prevent blowing out debris or fixture seals. | =0.50 |

## Pressure Parameters

| Pressure | Description | Example Setting |
|---|---|---|
| Minimum Pressure<br>**P1\P\Minimum Pressure** | The value that must be reached before the Prefill set point is reached and must be maintained through fill and stabilization segments or the testing cycle will end as a Severe Leak. | =0.3 bar |
| Target Pressure<br>**P1\P\Target Pressure** | The specified test pressure for the part. For vacuum test pressures enter as positive values if psiv (Vacuum) was selected as the pressure unit. Enter as a negative if psig was selected as the pressure unit. (i.e. A test pressure 9.7 psia would entered as 5 psiv or -5 psig.) Pressure loss may be corrected to the Target Pressure. | =0.4 bar |
| Maximum Pressure<br>**P1\P\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. | =0.5 bar |
| Target Press Window<br>**P1\P\Target Press Window** | This is a window (default - +/-50%) set about the Target Pressure that must be maintained during the Test segment of the testing cycle. It generates a Target Pressure Low or High Malfunction if the actual pressure falls outside this window during test. | =50% |

## Test Parameters

| TST Parameter | Description | Example Setting |
|---|---|---|
| Low Limit Loss<br>**P1\S\Low Limit Loss** | Lower set point value used to evaluate test results. | =-0.50 sccm |
| High Limit Loss<br>**P1\S\High Limit Loss** | Upper set point value used to evaluate test results | =0.13 sccm |
| EDC Enable<br>**P1\S\EDC Enabled** | Enables Environmental Drift Compensation | =Yes |
| EDC Percentage<br>**P1\S\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. | =25% |
| EDC Quantity<br>**P1\S\EDC Quantity** | Defines the number of test results within the EDC band used to calculate drift. | =10 |

# Pressure Decay-Leak Std

*This section explains the parameters for conducting a pressure decay test and correlating the pressure loss 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.*

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. The leak test instrument translates the pressure loss value measured over the fixed test time to a leak or flow rate.

The tables that follow give the parameters (and descriptions) used to setup a Pressure Decay Test that correlates the pressure loss result to a flow rate using a leak standard.

## Timer Parameters

| Timer | Description | Example Setting |
|---|---|---|
| Prefill<br>**P1\R\Prefill** | Checks for excessively leaking parts or lack of pressure. Set as a % of fill time, for fixed fill time tests. Maximum time to reach the minimum pressure. | =50% |
| Fill<br>**P1\R\Fill** | Time to enable part to reach the Target Pressure. It may also be used as time to stabilize part pressure with additional air. | =2.00 |
| Stabilize<br>**P1\R\Stabilize** | Time to stabilize part pressure while isolated from the pressure regulator. This time directly affects the repeatability of the test. | =5.00 |
| Test<br>**P1\R\Test** | The precise time over which to measure pressure drop or decay or the precise end time to measure pressure rise. | =10.00 |
| Exhaust<br>**P1\R\Exhaust** | Time to relieve or vent part pressure before signaling the end of test. Need time to prevent blowing out debris or fixture seals. | =0.50 |
| Relax<br>**P1\R\Relax** | Timer used during Program Cal sequence as a delay between tests to allow the part to recover to repeatable virgin state. Usually short relax times result in decreasing pressure losses (flows) in successive tests. | =5.00 |

## Pressure Parameters

| Pressure | Description | Example Setting |
|---|---|---|
| Minimum Pressure<br>**P1\P\Minimum Pressure** | The value that must be reached before the Prefill set point is reached and must be maintained through fill and stabilization timers or the testing cycle will end as a Severe Leak. | =0.3 bar |
| Target Pressure<br>**P1\P\Target Pressure** | The specified test pressure for the part. For vacuum test pressures enter as positive values if psiv was selected as the pressure unit. Enter as a negative if psig was selected as the pressure unit. (i.e. A test pressure 9.7 psia would entered as 5 psiv or -5 psig.) Pressure loss may be corrected to the Target Pressure. | =0.4 bar |
| Maximum Pressure<br>**P1\P\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. | =0.5 bar |
| Target Press Window<br>**P1\P\Target Press Window** | This value is not visible. It is a window (default - +/-50%) set about the Target Pressure that must be maintained during the Test segment of the testing cycle. It generates a Target Pressure Low or High Malfunction if the actual pressure falls outside this window during test. | =50% |

## Test Parameters

| TST Parameter | Description | Example Setting |
|---|---|---|
| Low Limit Rate<br>**P1\S\Low Limit Leak** | Lower set point value used to evaluate test results. | =-0.50 sccm |
| High Limit Rate<br>**P1\S\High Limit Leak** | Upper set point value used to evaluate test results | =0.13 sccm |
| Max Mstr+Leak Loss<br>**P1\S\Max Mstr+Leak Loss** | Maximum pressure loss allowed during either test in the Program Cal routine. Prevents the acceptance of a calibration with excessive pressure loss due to part or fixture leaks. Set slightly higher than max loss during Program Cal. | =0.100 dbar |
| Min Master Loss<br>**P1\S\Min Master Loss** | Minimum pressure loss or flow allowed during either test in Program Cal routine. Prevents the acceptance of a calibration of a blocked part or test line. | =-0.001 dbar |
| Min Perform Factor<br>**P1\S\Min Perform Factor** | Minimum value for Performance Factor calculated at completion of Program Cal routine. Resultant evaluation of ratio of Master Part Loss (Flow) to Master+Leak Loss (Flow), Test Pressure, and loss (flow) due to Leak Std. | =30 PF |
| Leak Std Cal Flow<br>**P1\S\Leak Std Cal Flow** | Certified flow value of Leak Standard used to calibrate instrument. This parameter is only viewable in this location if the Leak Std/Cal Define parameter is set to "Program". | =0.13 sccm |
| Leak Std Cal Press<br>**P1\S\Leak Std Cal Press** | Certified pressure at which Leak Standard Flow was calibrated. This parameter is only viewable in this location if the Leak Std/Cal Define parameter is set to "Program". | =1.00 bar |
| EDC Enable<br>**P1\S\EDC Enabled** | Enables Environmental Drift Compensation | =Yes |
| EDC Percentage<br>**P1\S\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. | =25% |
| EDC Quantity<br>**P1\S\EDC Quantity** | Defines the number of test results within the EDC band used to calculate drift. | =10 |

## Program Calibration

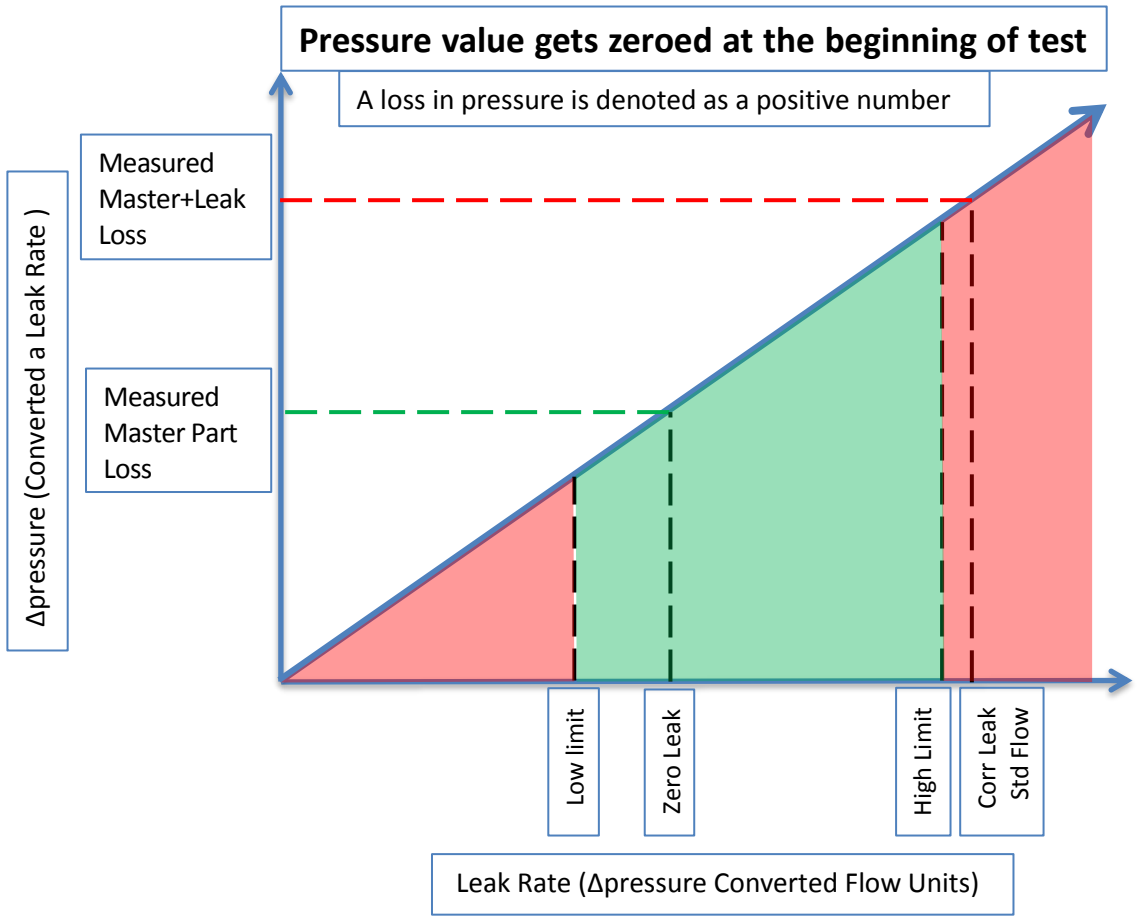
In order to convert the pressure loss measured by the instrument to a leak (flow) rate, the instrument uses a leak standard and needs to run the "Program Cal" procedure. This procedure requires at least one known non-leaking part referred to as a "master part ". This procedure tests a non-leaking master 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 the Features chapter of the Sentinel instrument user manual.

*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.*

Below is a graph that shows how a pressure loss test result is correlated to a flow rate using a calibrated leak standard. The values are stored in the program after a successful 2-cycle calibration routine.



## Initiating the Program Cal Sequence

To initiate a Program Cal sequence, first insert a master non-leaking part or buck into the system, then send the Program AutoCal command. Ensure that the correct program number is selected in the instrument before starting. Only 'Pressure Decay – Leak Std' and 'Differential Pressure Decay – Leak Std' test types can be calibrated.

```
> M\S1TCAP=1
> M\S1TAutoCal
```

The instrument will conduct an initial test of the non-leaking master part to measure the pressure loss associated with zero leak. 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. After the initial test is completed, you will be prompted to add a calibrated leak orifice to the test circuit:

```
97EA076 P       PROGRAM CALIBRATION - Please connect Leak
Standard.  Select OK or START to continue calibration, or
CANCEL to quit
```

Connect the leak standard, and send a START or KEY ENTER command to begin the second phase of calibration, or a KEY EXIT to cancel the sequence.

```
> M\S1TStart
```

The system will conduct a second test with the known calibrated leak standard included in the test. The pressure loss value result for this test is saved as the Master+Leak Loss.

Upon the successful completion of the Program Cal routine, the instrument will calculate a 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. Generally, longer timer settings will produce higher Performance Factors and improved Gage R&R performance.

***Note: The instrument will require a Program Cal Sequence if any parameters are modified that effects the calibration.***

Several conditions must be met during the Program Calibration procedure for the instrument to accept and store the calibration results. If the procedure does not meet these conditions, error messages will be sent at the completion of tests. Refer to the Test Parameters table on page 26 for calibration limits.

If the Program Cal routine is successfully completed, a Program Cal Passed message will be displayed. If there are any problems during the Program Cal sequence an error will be displayed. Refer to Appendix A – Messages & Error Codes for a description of error codes.

## Calibration Parameters

Calibration parameters are values that are measured or calculated as a result of the Program Cal routine for a pressure decay leak rate test. These values are essential to running a successful leak test and should not be manually overwritten. The table below describes the parameters.

| Parameter | Description |
|---|---|
| Performance Factor<br>**P1\C\Performance Factor** | Resultant evaluation of ratio of Master Part Loss (Flow) to Master+Leak loss (Flow), Test Pressure, and loss (flow) due to Leak Std |
| Master Part Press<br>**P1\C\Master Part Press** | Measured pressure at the beginning of the test segment during the first test of the Program Cal process for the non-leaking master part. |
| Master+Leak Press<br>**P1\C\Master+Leak Press** | Measured pressure at the beginning of the test cycle of second test during Program Cal process for the master part with the leak standard introduced to the pneumatic test circuit. |
| Master Part Loss<br>**P1\C\Master Part Loss** | Measured pressure loss for the non-leaking master part during the first test of Program Cal process |
| Master+Leak Loss<br>**P1\C\Master+Leak Loss** | Measured pressure loss during the second test of Program Cal for the master part with the leak standard introduced to the pneumatic test circuit. |
| Corr. Leak Std Flow<br>**P1\C\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. |

# Diff Pressure (DP) Decay-Leak Std

*This section explains the 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.
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 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 following Chart gives an overview of the parameters used to setup a Pressure Differential Test and correlating 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.

The tables that follow give the parameters (and descriptions) used to setup a Differential Pressure Decay Test that correlates the pressure loss result to a flow rate using a leak standard.

## Timer Parameters

| Timer | Description | Example Setting |
|---|---|---|
| Prefill<br>**P1\R\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. | =50% |
| Fill<br>**P1\R\Fill** | Time to enable part to reach the Target Pressure. It may also be used as time to stabilize part pressure with additional air. | =2.00 |
| Balance<br>**P1\R\Balance** | Time to allow the DP sensor to be introduced into the test circuit. The reference volume and test part should be close to fully charged before the balance portion of the test. | =1.00 |
| Stabilize<br>**P1\R\Stabilize** | Time to stabilize part pressure while isolated from the pressure regulator. This time directly affects the repeatability of the test. | =5.00 |
| Test<br>**P1\R\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. | =10.00 |
| Exhaust<br>**P1\R\Exhaust** | Time to relieve or vent part pressure before signaling the end of test. Need time to prevent blowing out debris or fixture seals. | =0.50 |
| Relax<br>**P1\R\Relax** | Amount of time allocated after Tooling Retract segment for execution before continuing to the next test. | =5.00 |

## Pressure Parameters

| Pressure | Description | Example Setting |
|---|---|---|
| Minimum Pressure<br>**P1\P\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 | =0.3 bar |
| Target Pressure<br>**P1\P\Target Pressure** | Target test pressure. Also used as a setpoint for the Electronic Regulator. | =0.4 bar |
| Maximum Pressure<br>**P1\P\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. | =0.5 bar |

## Test Parameters

| TST Parameter | Description | Example Setting |
|---|---|---|
| Low Limit Leak<br>**P1\S\Low Limit Leak** | Lower set point value used to evaluate test results of parts. | =-0.50 sccm |
| High Limit Leak<br>**P1\S\High Limit Leak** | Upper set point value used to evaluate test results of parts. | =0.13 sccm |
| Decay Direction<br>**P1\S\Decay Direction** | Defines whether the instrument is set to read pressure drop or pressure gain. In most circumstances Loss should be used, where a positive delta pressure value indicates pressure drop on the test circuit. | =Loss |
| Max Mstr+Leak Loss<br>**P1\S\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. | =0.100 dbar |
| Min Master Loss<br>**P1\S\Min Master Loss** | Minimum pressure loss allowable for the Master Part with Leak Standard during the calibration cycle. Use to prevent calibration to the Self-Test Cap. | =-0.001 dbar |

*Note: This table is continued on the next page.*

| TST Parameter | Description | Example Setting |
|---|---|---|
| Min Perform Factor<br>**P1\S\Min Perform Factor** | Minimum acceptable value for the Performance Factor compared after the calibration cycle to prevent improper calibration. | =30 PF |
| Leak Std Cal Flow<br>**P1\S\Leak Std Cal Flow** | Certified flow value of Leak Standard used to calibrate instrument. This parameter is only viewable in this location if the Leak Std/Cal Define parameter is set to "Program". | =0.13 sccm |
| Leak Std Cal Press<br>**P1\S\Leak Std Cal Press** | Certified pressure at which Leak Standard Flow was calibrated. This parameter is only viewable in this location if the Leak Std/Cal Define parameter is set to "Program". | =1.00 bar |
| EDC Enable<br>**P1\S\EDC Enabled** | Enables Environmental Drift Compensation | =Yes |
| EDC Percentage<br>**P1\S\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. | =25% |
| EDC Quantity<br>**P1\S\EDC Quantity** | Defines the number of test results within the EDC band used to calculate drift. | =10 |

## 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" procedure. This procedure requires one known non-leaking part referred to as a "master part", and a calibrated leak orifice. The calibration will first test the non-leaking master part connected to the instrument using the timers and pressures established for the program, then test the non-leaking part with the leak orifice installed.;

*Note: For more information on this, see Program Calibration on page 27 of this guide.*

## Initiating the Program Cal Sequence

To initiate a Program Cal sequence, first insert a master non-leaking part or buck into the system, then send the Program AutoCal command. Ensure that the correct program number is selected in the instrument before starting. Only 'Pressure Decay – Leak Std' and 'Differential Pressure Decay – Leak Std' test types can be calibrated.

```
> M\S1TCAP=1
> M\S1TAutoCal
```

The instrument will conduct an initial test of the non-leaking master part to measure the pressure loss associated with zero leak. 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. After the initial test is completed, you will be prompted to add a calibrated leak orifice to the test circuit:

```
97EA076 P       PROGRAM CALIBRATION - Please connect Leak
Standard.  Select OK or START to continue calibration, or
CANCEL to quit
```

Connect the leak standard, and send a START or KEY ENTER command to begin the second phase of calibration, or a KEY EXIT to cancel the sequence.

```
> M\S1TStart
```

The system will conduct a second test with the known calibrated leak standard included in the test. The pressure loss value result for this test is saved as the Master+Leak Loss.

Upon the successful completion of the Program Cal routine, the instrument will calculate a 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. Generally, longer timer settings will produce higher Performance Factors and improved Gage R&R performance.

***Note: The instrument will require a Program Cal Sequence if any parameters are modified that effects the calibration.***

Several conditions must be met during the Program Calibration procedure for the instrument to accept and store the calibration results. If the procedure does not meet these conditions, error messages will be sent at the completion of tests. Refer to the Test Parameters table on pages 32and 33 for calibration limits.

If the Program Cal routine is successfully completed, a Program Cal Passed message will be displayed. If there are any problems during the Program Cal sequence an error will be displayed. Refer to Appendix A – Messages & Error Codes for a description of error codes.

## Calibration Parameters

Calibration parameters are values that are measured or calculated as a result of the Program Cal routine for a pressure decay leak rate test. These values are essential to running a successful leak test and should not be manually overwritten. The table below describes the parameters.

| CAL Parameter | Description |
|---|---|
| Performance Factor<br>**P1\C\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. |
| Master Part Press<br>**P1\C\Master Part Press** | Absolute pressure data generated for the master part during the calibration cycle. |
| Master+Leak Press<br>**P1\C\Master+Leak Press** | Absolute pressure data generated for the master part with Leak Standard during the calibration cycle. |
| DP Master Part Loss<br>**P1\C\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. |
| DP Master+Leak Loss<br>**P1\C\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. |
| Master Part Loss<br>**P1\C\Master Part Loss** | Pressure loss during the calibration cycle of the Master Part and stored to represent normal loss at the specified Target Pressure. |
| Master+Leak Loss<br>**P1\C\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. |
| Corr. Leak Std Flow<br>**P1\C\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. |

# Chapter 5 – Test and Result Data

*This chapter gives a more in-depth explanation of the formatting of the instrument communication and explains how to decode the test results output.*

## Test Results via Communications

To see the menu settings described below, the communication interface must be set to "2-Way" and not to "Barcode". Depending on which type of communication is being used, these settings are located in:

**Main Menu > Global Config > RS232 1** icon > **RS232 1 Results**, or
**Main Menu > Global Config > RS232 2** icon > **RS232 2 Results**, or
**Main Menu > Global Config > Telnet 1** icon > **TCP/IP 1 Results**.

In order for the instrument to send the test result data automatically once the test is complete, the Global Config menu parameter for RS232 Results or TCP/IP 1 Results must be set to "On.".

Alternatively, the following commands can be sent via RS-232 or Telnet:

```
> I\S\RS232 1 Results=On

> I\R\RS232 2 Results=On


> I\1\Telnet 1 Results=On
```

Once this parameter is turned on, the Result Field data parameters show on the screen and can be set. 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.

## Table of Test Result Data Format

| Parameter | Number of Characters | Format | Example Text | Description of Example |
|---|---|---|---|---|
| Channel # | 4 | C## | C01 | Channel 1 |
| Program # | 4 | P## | P01 | Program 1 |
| Time | 13 | HH:MM:SS.XXX | 16:15:14.123 | 16 hours, 15 minutes, 14.123 seconds |
| Date | 9 | MM/DD/YY | 11/13/15 | January 01,2010 |
| Unique Id | 11 | ########## | 0000098353 | Unique test number |
| Program Evaluation | 3 | # | A | Accept |
| SPC Flag | 2 | # | - | SPC Test Data Result |
| Test Field | All Result Information | | | |
| Test Type | 8 | ### | PLR | 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 |

## Streaming Measured Data

The instrument has the ability to stream measured data via RS-232 or Telnet in real time while the test is being conducted. Streaming data can be enabled by using the following command:

```
> I\S\RS232 1 Streaming=On

> I\R\RS232 2 Streaming=On


> I\1\Telnet 1 Streaming=On
```

***IMPORTANT:***

***Streaming data must be turned on in order for certain Sentinel functionality to work, such as Set Regulator and Self-Test. You will also not receive any responses or prompt messages from the instrument if Telnet Streaming is set OFF.***

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 |

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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 & Error Codes

***Note: For the most up to date Test Message 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 B.)***

| 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 RS-232 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. |

| Message | Code | Description | Corrective Actions |
|---|---|---|---|
| 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. |
| Master Part Loss>Max Mstr+Leak Loss | C2 | The pressure loss during the first test of Program Cal 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 Program Cal 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 sequence of Program Cal 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 sequence of Program Cal 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. |

| Message | Code | Description | Corrective Actions |
|---|---|---|---|
| Master Flow>Max Master Flow | C7 | The flow value during the first sequence of Program Cal 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. |
| Master+Leak Flow<Master Flow | C8 | The flow value during the second sequence of Program Cal 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 Program Cal cycle 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. |

| Message | Code | Description | Corrective Actions |
|---|---|---|---|
| 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. | |
| 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 Electronic Regulator 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 sensor 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 sensor wiring. If this happens multiple times, replace the flow sensor. |

| Message | Code | Description | Corrective Actions |
|---|---|---|---|
| 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. | |
| 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. | |
| 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. | |
| 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. |

| Message | Code | Description | Corrective Actions |
|---|---|---|---|
| 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 Low | PL | Test pressure was below Minimum Pressure during fill cycle. This results in a severe leak. | |
| 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 |
| 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 |
| Part Not Stabilized | PS | This is an error in the Auto Setup Sequence that can occur if the instrument fails to stabilize the part. | |

| Message | Code | Description | Corrective Actions |
|---|---|---|---|
| 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. | |
| System Pressure Exceeded | SX | The system pressure of the unit was exceeded. | Check the pressure source and regulators |

| Message | Code | Description | Corrective Actions |
|---|---|---|---|
| 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. |
| 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 |

| Message | Code | Description | Corrective Actions |
|---|---|---|---|
| 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 – Communication Code Tables

*This appendix lists the codes for all Sentinel instruments.*
*Some codes may not apply to the instrument you are using.*

## Table 1: Data Type 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 |

## Table 2: 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 |

# Table 3: Test Evaluation Codes

type "TABLE EVALUATION"

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

| | Test Evaluation Code | Description |
|---|---|---|
| 31 | ER | SYSTEM ERROR - SERVICE REQ |
| 32 | FO | FLOW TRANSDUCER OVER-RANGE |
| 33 | FX | ERROR: EXCESSIVE FLOW |
| 34 | FZ | FLOW TRANSDUCER ZERO BAD |
| 35 | HF | HELIUM BACKGROUND FAULT |
| 36 | IC | INVALID INPUT CONFIGURATION |
| 37 | ID | INVALID CALIBRATION DATA |
| 38 | IE | INPUT INITIAL STATE ERROR |
| 39 | IF | I/O FAULT |
| 40 | IO | INVALID I/O CONFIGURATION |
| 41 | IP | INVALID PROGRAM SELECTED |
| 42 | IS | ISOLATION FAILURE |
| 43 | LD | ERROR: DUPLICATE TARGET LINK |
| 44 | LE | LEAK STD SELECT CONFIG ERROR |
| 45 | LL | ERROR: LINK EXECUTION LOOP |
| 46 | LN | ERROR: NO LINKS DEFINED |
| 47 | LO | ERROR: DISSIMILAR LINK ORDER |
| 48 | LP | ERROR: LINK PROG IS PARENT |
| 49 | LU | ERROR: LINK PROG UNDEFINED |
| 50 | MF | ERROR: PART MARK FAULT |
| 51 | MS | MAN FILL SWITCH |
| 52 | NE | NO EVENT OCCURRED |
| 53 | OC | ATMOSPHERIC PRESSURE COMPLETE |
| 54 | OE | ATMOSPHERIC PRESSURE ERROR |
| 55 | PA | ABOVE TARGET PRESSURE |
| 56 | PB | BELOW TARGET PRESSURE |
| 57 | PC | ERROR: PART NOT CHANGED |
| 58 | PE | PROGRAM CONFIGURATION ERROR |
| 59 | PF | PART NOT FULL |
| 60 | PH | TEST PRESSURE HIGH |

type “TABLE EVALUATION”

| | Test Evaluation Code | Description |
|---|---|---|
| 61 | PL | TEST PRESSURE LOW |
| 62 | PP | ERROR: PART NOT PRESENT |
| 63 | PR | POWER RESET |
| 64 | PS | PART NOT STABILIZED |
| 65 | PV | PROCESS FAULT |
| 66 | PX | PART NOT EXHAUSTED |
| 67 | QC | SEQUENCE COMPLETE |
| 68 | R | PROGRAM REJECT |
| 69 | R1 | PART REJECT - LEVEL 1 |
| 70 | R2 | PART REJECT - LEVEL 2 |
| 71 | R3 | PART REJECT - LEVEL 3 |
| 72 | RF | CHAMBER RISE FAULT |
| 73 | RH | PRE-PRESSURE HIGH |
| 74 | RL | PRE-PRESSURE LOW |
| 75 | RX | SOURCE PRESSURE EXCEEDED |
| 76 | S1 | LD ZERO < MIN |
| 77 | S2 | LD ZERO > MAX |
| 78 | S3 | LD LEAK < MIN |
| 79 | S4 | LD LEAK > MAX |
| 80 | SB | STOP BUTTON PRESSED |
| 81 | SC | START COMMON INPUT LOW |
| 82 | SE | PRESSURE SELECT CONFIG ERROR |
| 83 | SF | SELF-TEST FAILED |
| 84 | SH | ERROR: STOP INPUT HIGH |
| 85 | SI | STOP INPUT RECEIVED |
| 86 | SL | SEVERE LEAK |
| 87 | SM | SNIFFER MODE MISMATCH |
| 88 | SN | ERROR: SNIFFER NOT READY |
| 89 | SP | SELF-TEST PASSED |
| 90 | SR | SNIFFER READY INPUT FAULT |

| | Test Evaluation Code | Description |
|---|---|---|
| 91 | ST | SNIFFER TYPE MISMATCH |
| 92 | SU | SNIFFER UNITS MISMATCH |
| 93 | SX | SYSTEM PRESSURE EXCEEDED |
| 94 | TB | T-GAS BACKGROUND FAULT |
| 95 | TC | T-GAS CHAMBER CLEANUP FAULT |
| 96 | TE | ERROR: TOOLING NOT RESET |
| 97 | TI | ERROR: TWO-INPUT REQ TO START |
| 98 | TM | T-GAS MIN LEAK RATE FAULT |
| 99 | TP | TEST PORT SELECT CONFIG ERROR |
| 100 | TR | ERROR: TOOLING NOT RETRACTED |
| 101 | TS | TOOLING RESET |
| 102 | TX | ERROR: TOOLING NOT EXTENDED |
| 103 | VR | VENT PART RESET TOOLING |
| 104 | WA | WEIGHT ABOVE MAX |
| 105 | WB | WEIGHT BELOW MIN |
| 106 | WC | SCALE CONFIG ERROR |
| 107 | WH | SCALE WEIGHT HIGH |
| 108 | WL | SCALE WEIGHT LOW |
| 109 | WR | SCALE NOT READY |
| 110 | WS | SCALE NOT STABLE |
| 111 | XC | TRANSDUCER CAL COMPLETE |
| 112 | XE | TRANSDUCER CAL ERROR |
| 113 | XF | PRESSURE TRANSDUCER FAULT |
| 114 | XH | EXT SWITCH DID NOT GO HIGH |
| 115 | XL | EXT SWITCH DID NOT GO LOW |
| 116 | XO | TRANSDUCER OVER-RANGE |
| 117 | XP | EXTERNAL XDCR PRESS |
| 118 | XV | TRANSDUCER VERIFY COMPLETE |
| 119 | XZ | TRANSDUCER ZERO BAD |

# Table 4: 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 | DLY | Delay |
| 25 | DPD | Differential Pressure Decay Test |
| 26 | DPL | Differential Pressure Decay - Leak Std Test |
| 27 | DPS | Setup - DP Transducer Setpoint |
| 28 | DPT | Rate of Pressure Loss Test |
| 29 | DTV | Setup - DP Transducer Verification |
| 30 | DTZ | Setup - DP Transducer Zero |

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

type “TABLE SEGMENT”

| | Segment Code | Description |
|---|---|---|
| 61 | PRF | Prefill until Pressure |
| 62 | PRF | Proof Test |
| 63 | PRI | Internal - Pre-Seq |
| 64 | PRI | Internal - Evaluate Part Result |
| 65 | PRP | Prefill Pre-Pressure |
| 66 | PRS | Step Proof |
| 67 | PSI | Internal - Post-Seq |
| 68 | PTS | Setup - Pressure Transducer Setpoint |
| 69 | PTV | Setup - Pressure Transducer Verification |
| 70 | PTZ | Setup - Pressure Transducer Zero |
| 71 | PVF | Pressure Verify |
| 72 | RCF | Refrigerant Iso Off |
| 73 | RCX | Refrigerant CS Isolation |
| 74 | REC | Exhaust - T-Gas |
| 75 | REF | Refrigerant Fill |
| 76 | RET | Tooling Motion Retract |
| 77 | REV | Exhaust - Re-Evacuate |
| 78 | RFE | Refrigerant Evac |
| 79 | RFM | Refrigerant Manual Fill |
| 80 | RFS | Stabilize Scale |
| 81 | RFT | Refrigerant Fill |
| 82 | RFX | Refrigerant Stabilize |
| 83 | RL | Calibration Relax |
| 84 | RPS | Refrigerant Part Switch |
| 85 | RTE | Ramp to Pressure Event Test |
| 86 | RTF | Ramp to Flow Event Test |
| 87 | RTI | Ramp to Digital Input Event Test |
| 88 | RVN | Refrigerant Vent |
| 89 | SCI | Setup - Scale Init |
| 90 | SD1 | Setup - Sniffer idle |

| | Segment Code | Description |
|---|---|---|
| 91 | SDP | Stabilize for DP |
| 92 | SFS | Stabilize Tracer |
| 93 | SGL | Fill Tracer Gross |
| 94 | SGS | Stabilize Tracer Gross |
| 95 | SI1 | Setup - Sniffer Init |
| 96 | SI2 | Setup - Sniffer Init 2 |
| 97 | SLE | Tooling Seal Extend |
| 98 | SLR | Tooling Seal Retract |
| 99 | SME | Setup - Manifold Exhaust |
| 100 | SMF | Setup - Manifold Fill |
| 101 | SMI | Setup - Manifold Isolate |
| 102 | SNF | Sniffer Test |
| 103 | SNG | Sniffer Gross Test |
| 104 | SNW | Stabilize Tracer Wait |
| 105 | SPF | Fill Step |
| 106 | SPL | Setup - Pressure Select |
| 107 | SPR | Setup - Pre-Seq |
| 108 | SPS | Setup - Post-Seq |
| 109 | SSD | Stabilize Step Dwell |
| 110 | SSR | Setup - Set Regulator |
| 111 | STE | Stabilize Evac |
| 112 | STF | Stabilize for Flow |
| 113 | STG | General Stabilize |
| 114 | STR | Setup - Transducer Residual |
| 115 | STR | Stabilize Reference Volume |
| 116 | STS | Stabilize until Slope |
| 117 | SVD | Evac Test |
| 118 | SXT | Stabilize for Xdcr Test |
| 119 | TMC | Tooling Motion Control |
| 120 | XDR | Transducer Test |

# Table 5: 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 | ARC | Autorun Cycle Count |
| 13 | ARE | Autorun Enable |
| 14 | ARM | Autorun Method |
| 15 | ARR | Autorun Relax |
| 16 | ASA | Short Autozero |
| 17 | ASD | Accept Std Dev |
| 18 | ASM | Auto Setup Method |
| 19 | ASP | Accept SPC Std Dev |
| 20 | ATD | Anti-Tie-Down |
| 21 | AZD | Autozero Delay |
| 22 | AZE | Autozero Enable |
| 23 | Ain | Analog Input |
| 24 | Aot | Analog Output |
| 25 | BCM | Barcode Method |
| 26 | BR | Barcode Required |
| 27 | CA | Accept Cycles |
| 28 | CAP | Calibrate Percent |
| 29 | CC | Capability Code |
| 30 | CCD | Ch Evac Valve Dly |
| 31 | CCP | Clear Prog Counters |
| 32 | CCR | Clear Chan Results |
| 33 | CCS | Clear Chan Counters |
| 34 | CEF | Chamber Evac Limit |
| 35 | CEV | Chamber Evac Close |
| 36 | CFS | Chamber Clean |
| 37 | CHM | Post-Purge Method |
| 38 | CHO | Chamber Post-Purge |
| 39 | CHP | Chamber Pressure |
| 40 | CHV | Chamber Volume |
| 41 | CID | CS Iso Delay |
| 42 | CLF | Corr. Leak Std Flow |
| 43 | CLM | Clamshell |
| 44 | CLP | Check Limit Percent |
| 45 | CLR | Cumulative Leak |

| | Test Data Identifier Code | Description |
|---|---|---|
| 46 | CM | Cal Method |
| 47 | CM | Malfunction Cycles |
| 48 | CMN | Clean Min Pressure |
| 49 | CMX | Maximum Pressure |
| 50 | COF | Continue on Fail |
| 51 | COL | Cutoff Limit |
| 52 | CP | Current Precision |
| 53 | CPP | Copy Program |
| 54 | CPS | TLR Change/Sec |
| 55 | CPT | Consecutive Points |
| 56 | CPT | Consecutive Points |
| 57 | CR | Reject Cycles |
| 58 | CRA | Clean Part Source |
| 59 | CRF | Pre-Purge |
| 60 | CRS | Chamber Crossover |
| 61 | CSC | Cycles Since Cal |
| 62 | CSN | Clear Since New Counter |
| 63 | CSN | Cycles Since New |
| 64 | CST | Custom Self-Test |
| 65 | CT | Total Cycles |
| 66 | CTG | Target Pressure |
| 67 | CTP | Copy to Target Prog |
| 68 | CTR | Clean Part Timer |
| 69 | DA | Analog D/A |
| 70 | DD | Decay Direction |
| 71 | DFL | Direct Flow |
| 72 | DL | Diff Press Loss |
| 73 | DLL | DP Master+Leak Loss |
| 74 | DLR | Diff Press Loss Rd |
| 75 | DLT | Delay Timer |
| 76 | DML | DP Master Part Loss |
| 77 | DMR | DP Mstr Part Loss Read |
| 78 | DP | Diff Pressure |
| 79 | DPI | DP Iso Percent |
| 80 | DPP | Δ Press Precision |
| 81 | DVF | Vent During Fill |
| 82 | DVM | Test Mode |
| 83 | DVO | Device Mode |
| 84 | Dt | Date |
| 85 | ECL | ERC Crossover Limit |
| 86 | EDC | EDC Offset |
| 87 | EDE | EDC Enabled |
| 88 | EDP | Event ΔP |
| 89 | EDP | EDC Percentage |
| 90 | EDQ | EDC Quantity |

type “TABLE VARIABLE”

| | Test Data Identifier Code | Description |
|---|---|---|
| 91 | EDT | Event ΔT |
| 92 | EIL | ERC Increment Limit |
| 93 | EMP | Ext Xdcr Pressure |
| 94 | ENB | E-NOB |
| 95 | ENC | Enable Calibration |
| 96 | ENT | Enable Tooling I/O |
| 97 | EOL | ERC Offset Limit |
| 98 | EPP | Pressure Precision |
| 99 | EPR | Pressure Reference |
| 100 | ERA | Atm Pressure |
| 101 | ERC | ERC Method |
| 102 | ERE | ERC Enabled |
| 103 | ERP | ERC Rate/Period |
| 104 | ERQ | ERC Quantity |
| 105 | ERR | E-Regulator Rest |
| 106 | ERV | Re-Evac After Test |
| 107 | ESC | Ext Switch Low Chk |
| 108 | ESN | External Sniffer |
| 109 | ESP | Exhaust Setpoint |
| 110 | ET | Elapsed Time |
| 111 | ETP | Evacuation Setpoint |
| 112 | ETP | Fine T-Gas Target |
| 113 | ETW | ERC Target Window |
| 114 | ETW | ERC Target Window |
| 115 | ETY | Edge Type |
| 116 | EUP | Pressure Unit |
| 117 | EVA | Evacuation Source |
| 118 | EVC | Eval Condition |
| 119 | EVD | Vacuum Decay |
| 120 | EVL | Test Evaluation |
| 121 | EVM | Allow Evac Limit |
| 122 | EVP | Event Pressure |
| 123 | EVT | Event Type |
| 124 | EXD | Evacuation Xdcr |
| 125 | EXP | Execution Pause |
| 126 | FCC | Force Cal Cycles |
| 127 | FCD | FCal Date Limit |
| 128 | FCL | FCal Cycle Limit |
| 129 | FCM | Force Cal Mode |
| 130 | FCT | FCal Time Limit |
| 131 | FCT | Force Cal Time |
| 132 | FEL | Flow Event Limit |
| 133 | FL | Flow |
| 134 | FLD | Fine T-Gas Decay |
| 135 | FLF | Fine T-Gas Fill |

| | Test Data Identifier Code | Description |
|---|---|---|
| 136 | FMV | Finish Mix Verify |
| 137 | FNB | FF-NOB |
| 138 | FP | Flow Precision |
| 139 | FPR | Fill Pressure |
| 140 | FPS | Fine Sample |
| 141 | FSW | Final Source Weight |
| 142 | FTA | Dwell |
| 143 | FTA | Fill |
| 144 | FTX | Test Failed Text |
| 145 | Fdb | Tooling Feedback |
| 146 | GLD | Gross T-Gas Decay |
| 147 | GLF | Gross T-Gas Fill |
| 148 | GLN | Gross T-Gas Min |
| 149 | GLT | Gross T-Gas Target |
| 150 | GLX | Gross T-Gas Max |
| 151 | GPS | Gross Sample |
| 152 | GPT | Gross Fill Pulse |
| 153 | HLE | High Limit Event |
| 154 | HLF | High Limit Flow |
| 155 | HLL | High Limit Loss |
| 156 | HLP | High Limit Pressure |
| 157 | HLQ | High Limit Leak |
| 158 | HLR | High Limit Rate |
| 159 | HLV | High Limit %Vref |
| 160 | I/O | I/O ID |
| 161 | IET | Event Type |
| 162 | IF | Instrument Flow |
| 163 | IIS | Input Initial State |
| 164 | ILS | Level State |
| 165 | ILT | Level Time |
| 166 | IPR | Close Inner Purge |
| 167 | IS | Input State |
| 168 | LAV | Leak Alarm Volume |
| 169 | LCD | Leak Std/Cal Define |
| 170 | LCD | Leak Std Cal Date |
| 171 | LCF | Correction Factor |
| 172 | LDP | Leak Det Precision |
| 173 | LDT | Dev Zero Delay |
| 174 | LDU | Leak Det Unit |
| 175 | LDZ | Device Zero |
| 176 | LF | Master+Leak Flow |
| 177 | LFC | Leak Std Cal Flow |
| 178 | LFR | Master+Leak Flow Rd |
| 179 | LIN | Linearity |
| 180 | LKM | Link Motion |

type "TABLE VARIABLE"

| | Test Data Identifier Code | Description |
|---|---|---|
| 181 | LL | Master+Leak Loss |
| 182 | LLE | Low Limit Event |
| 183 | LLF | Low Limit Flow |
| 184 | LLL | Low Limit Loss |
| 185 | LLP | Low Limit Pressure |
| 186 | LLQ | Low Limit Leak |
| 187 | LLR | Master+Leak Loss Rd |
| 188 | LLR | Low Limit Rate |
| 189 | LLV | Low Limit %Vref |
| 190 | LMP | Link Motion Preempt |
| 191 | LNL | Linearity Limit |
| 192 | LOF | Loss Offset |
| 193 | LQ | Master+Leak QL |
| 194 | LQD | DP Mstr+Lk QL Rd |
| 195 | LQD | DP Master+Leak QL |
| 196 | LQF | Master+Leak QF Rd |
| 197 | LQF | Master+Leak QF |
| 198 | LQR | Master+Leak QL Rd |
| 199 | LR | Leak Rate |
| 200 | LRC | Leak Std Recert |
| 201 | LSC | Leak Std Chk |
| 202 | LSP | Leak Std Pressure |
| 203 | LSS | Leak Std Select |
| 204 | LSV | Leak Std Value |
| 205 | LV | Launch Validation |
| 206 | MF | Master Part Flow |
| 207 | MFO | Manual Fill |
| 208 | MFR | Master Part Flow Rd |
| 209 | MFT | Manual Fill |
| 210 | ML | Master Part Loss |
| 211 | MLR | Master Part Loss Rd |
| 212 | MMF | Min Master Flow |
| 213 | MMF | Min Master Flow |
| 214 | MML | Min Master Loss |
| 215 | MNT | Min Tare Weight |
| 216 | MO | Master Flow Offset |
| 217 | MOR | Master Flow Offset |
| 218 | MPC | Malfunction Percent |
| 219 | MPF | Min Perform Factor |
| 220 | MPP | Max System Pressure |
| 221 | MQ | Master Part QL |
| 222 | MQD | DP Mstr Part QL Rd |
| 223 | MQD | DP Master Part QL |
| 224 | MQF | Master Part QF Rd |
| 225 | MQF | Master Part QF |
| 226 | MQR | Master Part QL Rd |
| 227 | MSL | Reject Rate |
| 228 | MSO | MS Iso Open Delay |
| 229 | MSP | Max Pressure - Opt |
| 230 | MSR | Mark Severe Lk Rej |
| 231 | MST | Mass Spec Purge |
| 232 | MTM | Min T-Gas Mode |
| 233 | MTS | T-Gas Source |
| 234 | MV | T-Gas Mix Verify |
| 235 | MVF | T-Gas Target Press |
| 236 | MVH | Leak Rate High Limit |
| 237 | MVL | Leak Rate Low Limit |
| 238 | MVM | T-Gas Leak Rate |
| 239 | MVS | Start Mix Verify |
| 240 | MVT | T-Gas Fill Timer |
| 241 | MXT | Max Tare Weight |
| 242 | Mot | Motion Number |
| 243 | Mot | Number of Motions |
| 244 | NAM | Program Name |
| 245 | NBC | Number of Barcodes |
| 246 | NLK | Number of Links |
| 247 | NOP | Number of Options |
| 248 | NPP | Next Program |
| 249 | NPS | Number of Steps |
| 250 | NTP | Sample Points |
| 251 | NUM | Number of Programs |
| 252 | OLS | Open Leak Std |
| 253 | OPT | Option |
| 254 | P | Master Gauge Press |
| 255 | P | Instrument Pressure |
| 256 | P | Meas Pressure |
| 257 | P%V | Part %Vref |
| 258 | PC | Pneumatic Code |
| 259 | PCL | Leak Std Cal Press |
| 260 | PCR | Pressure Correction |
| 261 | PCT | Chamber Post-Purge |
| 262 | PDL | Press Delta Limit |
| 263 | PEP | Part Evac Fault |
| 264 | PET | Part Evac Limit |
| 265 | PEV | Part Evacuation |
| 266 | PEX | Partial Exhaust |
| 267 | PF | Performance Factor |
| 268 | PFL | Part Flow |
| 269 | PFM | Prefill Method |
| 270 | PG | Target Pressure |

type “TABLE VARIABLE”

| | Test Data Identifier Code | Description |
|---|---|---|
| 271 | PKP | Peak Pressure |
| 272 | PL | Pressure Loss |
| 273 | PLP | Predicted Loss |
| 274 | PLQ | Master+Leak Q-Press |
| 275 | PLR | Pressure Loss Rd |
| 276 | PLR | DP Mstr+Lk Loss Rd |
| 277 | PM | Master Part Press |
| 278 | PM | Part Mark |
| 279 | PMF | Part Mark Feedback |
| 280 | PML | Master+Leak Press |
| 281 | PMN | Minimum Pressure |
| 282 | PMQ | Master Part Q-Press |
| 283 | PMX | Maximum Pressure |
| 284 | PNM | Sniffer Test Point |
| 285 | PP | Pressure Precision |
| 286 | PP | Proof Pressure |
| 287 | PPC | Part Present Check |
| 288 | PPE | Pre-Press Enable |
| 289 | PPR | Pre-Pressure |
| 290 | PPS | Pre-Press Select |
| 291 | PPW | Pre-Pressure Window |
| 292 | PQ | Predicted Leak |
| 293 | PRF | Prefill |
| 294 | PRI | Programmable Input |
| 295 | PRO | Programmable Output |
| 296 | PRR | Pressure Restrict |
| 297 | PSL | Pressure Select |
| 298 | PSL | Pressure Select |
| 299 | PSL | Pressure Select |
| 300 | PSP | Setpoint Pressure |
| 301 | PST | Self-Test Pressure |
| 302 | PSV | Part Sniffer Type |
| 303 | PT | Target Pressure |
| 304 | PTF | Prefill |
| 305 | PTG | Gross Prefill |
| 306 | PTP | ΔP/ΔT Precision |
| 307 | PTS | Port Select |
| 308 | PTS | Part Seal |
| 309 | PTU | ΔP/ΔT Unit |
| 310 | PTX | Test Passed Text |
| 311 | PW | Weight Precision |
| 312 | Pp | Part Pressure |
| 313 | Pr | Ref Pressure |
| 314 | Pt | Test Pressure |
| 315 | Pt | Target Pressure |

| | Test Data Identifier Code | Description |
|---|---|---|
| 316 | Pt | Apply to Program # |
| 317 | Pt | Program Number |
| 318 | Pv | Estimated Part Size |
| 319 | QF | Quik Flow |
| 320 | QHL | Quik Test HL Band |
| 321 | QL | Quik Loss |
| 322 | QLL | Quik Test LL Band |
| 323 | QP | Quik Test Pressure |
| 324 | QPT | Quantity Points |
| 325 | QTE | Quik Test Enable |
| 326 | RAN | Number of Points |
| 327 | RAP | Analysis Pressure |
| 328 | RAS | Analysis Voltage |
| 329 | RAT | Analysis Percent |
| 330 | RAV | Reject Average |
| 331 | RC | Elec Regulator Cal |
| 332 | RC1 | EReg Zero DA Cal |
| 333 | RC2 | EReg Span DA Cal |
| 334 | RC3 | EReg Zero Base Cal |
| 335 | RC4 | EReg Span Base Cal |
| 336 | RCA | Analog Value |
| 337 | RCD | Last Cal Date |
| 338 | RCI | Instrument Pressure |
| 339 | RCP | Retention Cutoff |
| 340 | RCS | Setpoint Voltage |
| 341 | RCT | Last Cal Time |
| 342 | RCV | Master Value |
| 343 | RDI | Restore Default I/O |
| 344 | RDT | Reg Dwell Timer |
| 345 | RED | Refrgnt Vent Close |
| 346 | REG | Regulator |
| 347 | REO | Refrigerant Vent |
| 348 | REX | Refrigerant Vent |
| 349 | RFC | Fill Close Delay |
| 350 | RFL | Reference Loss |
| 351 | RL | Loss Rate |
| 352 | RLC | Run Leak Calibrate |
| 353 | RLR | Loss Rate Rd |
| 354 | RLV | Leak Std Value |
| 355 | RMX | EReg Span DA Cal |
| 356 | RNP | Number of Points |
| 357 | ROS | Reject on Slope |
| 358 | RPC | Reject Percentage |
| 359 | RPM | Ramp Method |
| 360 | RPP | Reject Program |
| 361 | RPP | Retain Part Press |

type “TABLE VARIABLE”

| | Test Data Identifier Code | Description |
|---|---|---|
| 362 | RR | Retract on Reject |
| 363 | RR | Ramp Rate |
| 364 | RRT | Reject Rate Total |
| 365 | RSI | Result Information |
| 366 | RSP | Slope Window |
| 367 | RSR | Slope Change/Sec |
| 368 | RST | Stabilize |
| 369 | RVH | High Limit Voltage |
| 370 | RVH | High Limit Voltage |
| 371 | RVL | Low Limit Voltage |
| 372 | RVL | Low Limit Voltage |
| 373 | RVP | Retain Volume Press |
| 374 | RXM | Pre-Evac Exhaust |
| 375 | SAM | Sample Size |
| 376 | SAS | Start Auto Setup |
| 377 | SCF | Cal Coefficient |
| 378 | SCL | Leak Std Value |
| 379 | SCO | Cal Offset |
| 380 | SCP | Start Clean Part |
| 381 | SCR | Reject Rate Percent |
| 382 | SCT | Scale Type |
| 383 | SEV | Leak Rate Window |
| 384 | SF | Standard Flow |
| 385 | SGN | Sample Gas Number |
| 386 | SIO | Sniffer Init |
| 387 | SMP | Sample Time |
| 388 | SN | Step Number |
| 389 | SNR | SNR |
| 390 | SP | Starting Pressure |
| 391 | SP | Standard Pressure |
| 392 | SPM | Fine Wait |
| 393 | SPT | Gross Wait |
| 394 | SR | Set Regulator |
| 395 | SRC | Start Calibration |
| 396 | SRH | LD Leak Val Max |
| 397 | SRL | LD Leak Val Min |
| 398 | SSW | Starting Source Weight |
| 399 | STL | Self-Test Level |
| 400 | STM | Self-Test Method |
| 401 | STN | Self-Test Program |
| 402 | STP | Target Press |
| 403 | STS | Start Self-Test |
| 404 | STS | Self-Test Source |
| 405 | STT | Self-Test Limit |
| 406 | STV | Step Target Press |
| 407 | STW | Target Window |

| | Test Data Identifier Code | Description |
|---|---|---|
| 408 | SXC | Start Calibration |
| 409 | SXT | Start Xdcr Test |
| 410 | SXV | Start Verification |
| 411 | SZH | LD Zero Val Max |
| 412 | SZL | LD Zero Val Min |
| 413 | Ser | Serial Number |
| 414 | Stn | Channel Number |
| 415 | T | Timer |
| 416 | T | Timer |
| 417 | TBF | Background Limit |
| 418 | TI | Iso Delay Timer |
| 419 | TL | Tooling Option |
| 420 | TLK | Test Leak Rate |
| 421 | TLP | Leak Rate Precision |
| 422 | TLR | T-Gas Leak Rate |
| 423 | TLU | Leak Rate Unit |
| 424 | TML | Min T-Gas Setpoint |
| 425 | TMN | Fine T-Gas Min |
| 426 | TMP | Temp Precision |
| 427 | TMX | Fine T-Gas Max |
| 428 | TP | Time Precision |
| 429 | TPP | Target Program |
| 430 | TPW | Target Press Window |
| 431 | TQ | Quik Test Timer |
| 432 | TR1 | Trigger 1 |
| 433 | TRA | T-Gas Source |
| 434 | TRM | T-Gas Recovery |
| 435 | TSM | T-Gas Sampling |
| 436 | TT | Test Sel Timer |
| 437 | TT | Test Execution Time |
| 438 | TTF | TracerMate Flags |
| 439 | TTY | Test Type |
| 440 | TTY | Test Type |
| 441 | TV | Valve Delay Timer |
| 442 | TW | Target Weight |
| 443 | TWN | Min Fill Weight |
| 444 | TWX | Max Fill Weight |
| 445 | Tcy | Desired Cycle Time |
| 446 | Tm | Time |
| 447 | Tm | Timer Mode |
| 448 | UC | Current Unit |
| 449 | UDP | Δ Pressure Unit |
| 450 | UF | Flow Unit |
| 451 | UP | Percent Unit |
| 452 | UP | Pressure Unit |
| 453 | UPD | Unit/Prec Define |

type “TABLE VARIABLE”

| | Test Data Identifier Code | Description |
|---|---|---|
| 454 | UT | Time Unit |
| 455 | UTM | Temperature Unit |
| 456 | UV | Voltage Unit |
| 457 | UV | Volume Unit |
| 458 | UW | Weight Unit |
| 459 | V | V |
| 460 | VAN | Valve A Num - Opt |
| 461 | VAP | Valve A PWM - Opt |
| 462 | VAT | Valve A Type - Opt |
| 463 | VBN | Valve B Num - Opt |
| 464 | VBP | Valve B PWM - Opt |
| 465 | VBT | Valve B Type - Opt |
| 466 | VC | Valve Code |
| 467 | VCN | Valve C Num - Opt |
| 468 | VCP | Valve C PWM - Opt |
| 469 | VCT | Valve C Type - Opt |
| 470 | VDN | Valve D Num - Opt |
| 471 | VDP | Valve D PWM - Opt |
| 472 | VDT | Valve D Type - Opt |
| 473 | VFL | Virtual Flow |
| 474 | VHT | Vent/Halt Tooling |
| 475 | VLP | Volume Precision |
| 476 | VLV | Valve Number |
| 477 | VNP | Number of Points |
| 478 | VP | Voltage Precision |
| 479 | VPS | Setpoint Pressure |
| 480 | VPW | Valve PWM |
| 481 | VSP | Setpoint Voltage |
| 482 | VWO | Residual Offset |
| 483 | WGT | Refrigerant Weight |
| 484 | WHL | High Limit |
| 485 | WIN | Stat History Length |
| 486 | WLL | Low Limit |
| 487 | XAN | Xdcr Zero LL |
| 488 | XAX | Xdcr Base Max |
| 489 | XBH | Xdcr Zero Hwin |
| 490 | XBL | Xdcr Zero Lwin |
| 491 | XC | Transducer Cal |
| 492 | XC1 | Xdcr Zero AD Cal |
| 493 | XC2 | Xdcr Span AD Cal |
| 494 | XC3 | Xdcr Zero Base Cal |
| 495 | XC4 | Xdcr Span Base Cal |
| 496 | XCA | Analog Value |
| 497 | XCB | Atm Pressure |
| 498 | XCD | Last Cal Date |
| 499 | XCF | Instrument Flow |

| | Test Data Identifier Code | Description |
|---|---|---|
| 500 | XCI | Instrument Pressure |
| 501 | XCL | Xdcr Current Limit |
| 502 | XCM | Master Reading |
| 503 | XCP | Cal Pressure |
| 504 | XCS | Setpoint Pressure |
| 505 | XCT | Last Cal Time |
| 506 | XCV | Master Value |
| 507 | XCX | Xdcr Cal X Array |
| 508 | XCY | Xdcr Cal Y Array |
| 509 | XFC | Xdcr Filter Code |
| 510 | XFP | Flow Precision |
| 511 | XID | Xdcr Iso Delay |
| 512 | XIS | Xdcr Span Inter Cal |
| 513 | XIZ | Xdcr Zero Inter Cal |
| 514 | XLF | Max Mstr+Leak Flow |
| 515 | XMF | Max Master Flow |
| 516 | XML | Max Mstr+Leak Loss |
| 517 | XMN | Xdcr Base Min |
| 518 | XMX | Xdcr Base Max |
| 519 | XNP | Number of Points |
| 520 | XOP | Crossover Pressure |
| 521 | XPC | Pressure Correction |
| 522 | XPM | Pressure Mode |
| 523 | XPP | Pressure Precision |
| 524 | XPR | Pressure Reference |
| 525 | XRL | Xdcr Residual Limit |
| 526 | XRW | Xdcr Residual Warn |
| 527 | XSP | Setpoint Pressure |
| 528 | XT | Transducer |
| 529 | XT | Xdcr Tare |
| 530 | XTG | Xdcr Tare Range |
| 531 | XTR | Xdcr Typ Residual |
| 532 | XUF | Flow Unit |
| 533 | XUP | Pressure Unit |
| 534 | XV | Transducer Verify |
| 535 | XVD | Verify Date |
| 536 | XVF | Instrument Flow |
| 537 | XVI | Instrument Pressure |
| 538 | XVM | Master Reading |
| 539 | XVS | Setpoint Pressure |
| 540 | XVT | Verify Time |
| 541 | XVV | Master Value |
| 542 | XZC | Xdcr Zero Check |
| 543 | XZH | Xdcr Zero HL |
| 544 | XZL | Xdcr Zero LL |
| 545 | XZW | Xdcr Zero Window |

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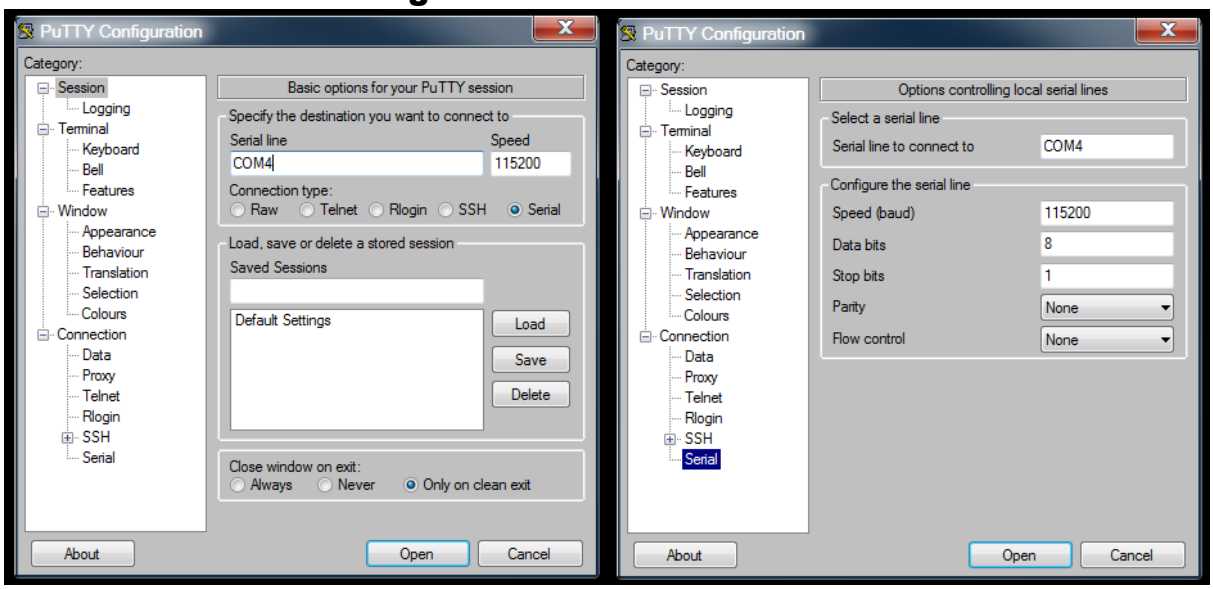
# Appendix C –
# Terminal Emulator Software Configuration

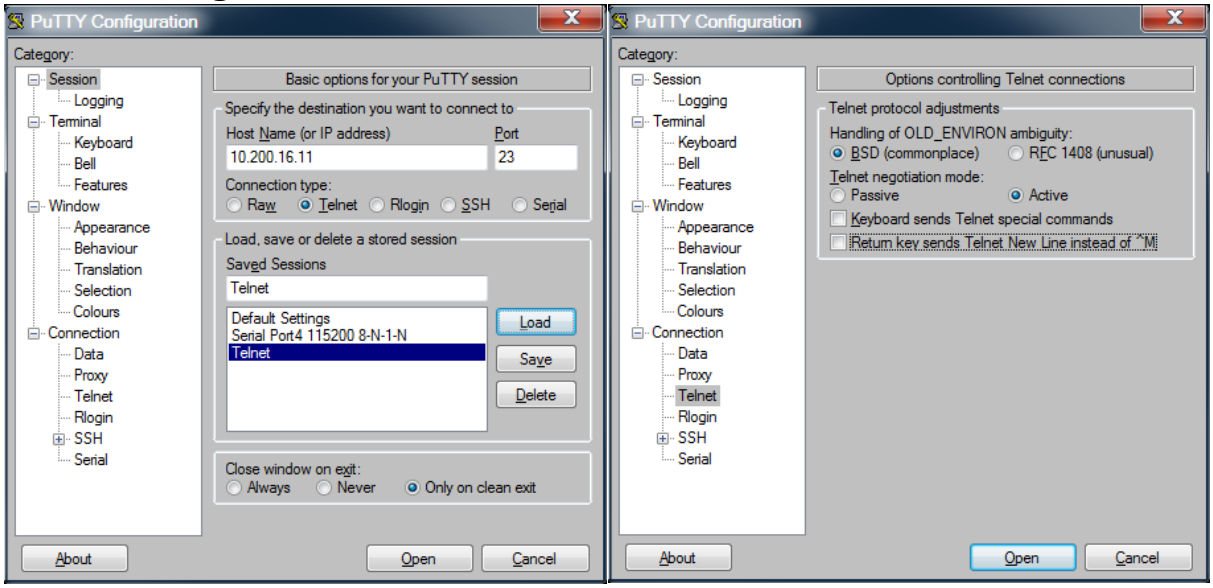
*A variety of tools can be configured to communicate with the Sentinel instrument. Acceptable configurations of each are shown in this appendix.*

## PuTTY

### RS-232 Serial Port Configuration

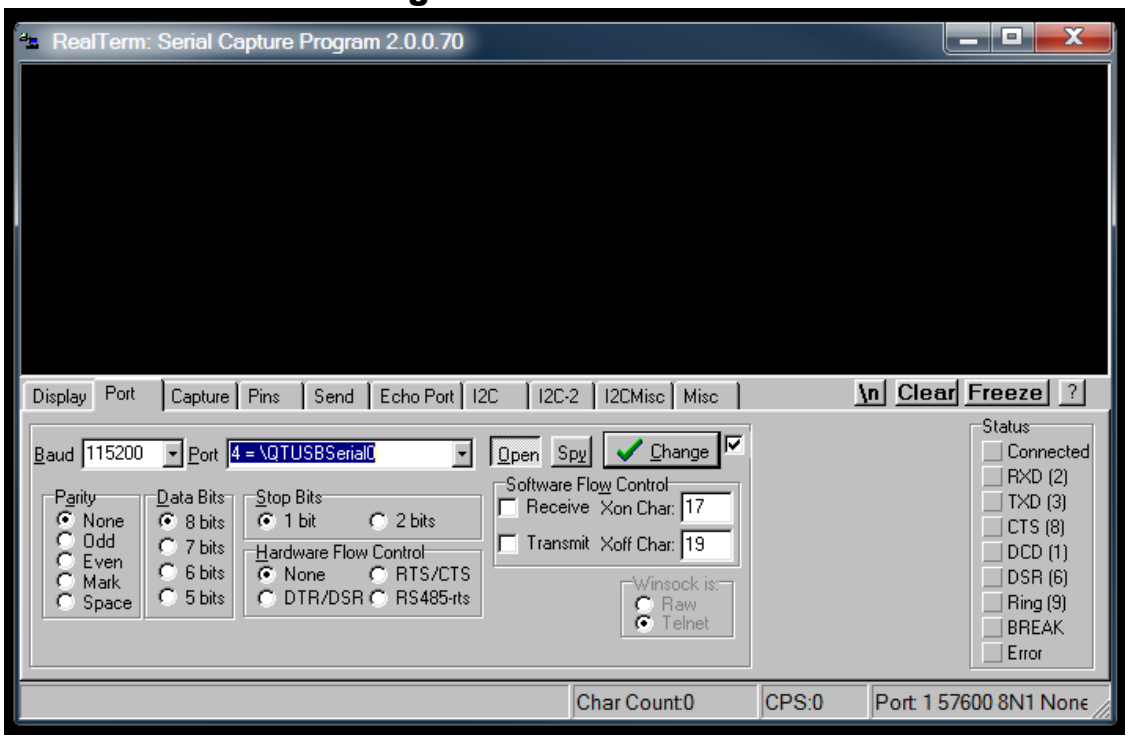



### Telnet Configuration

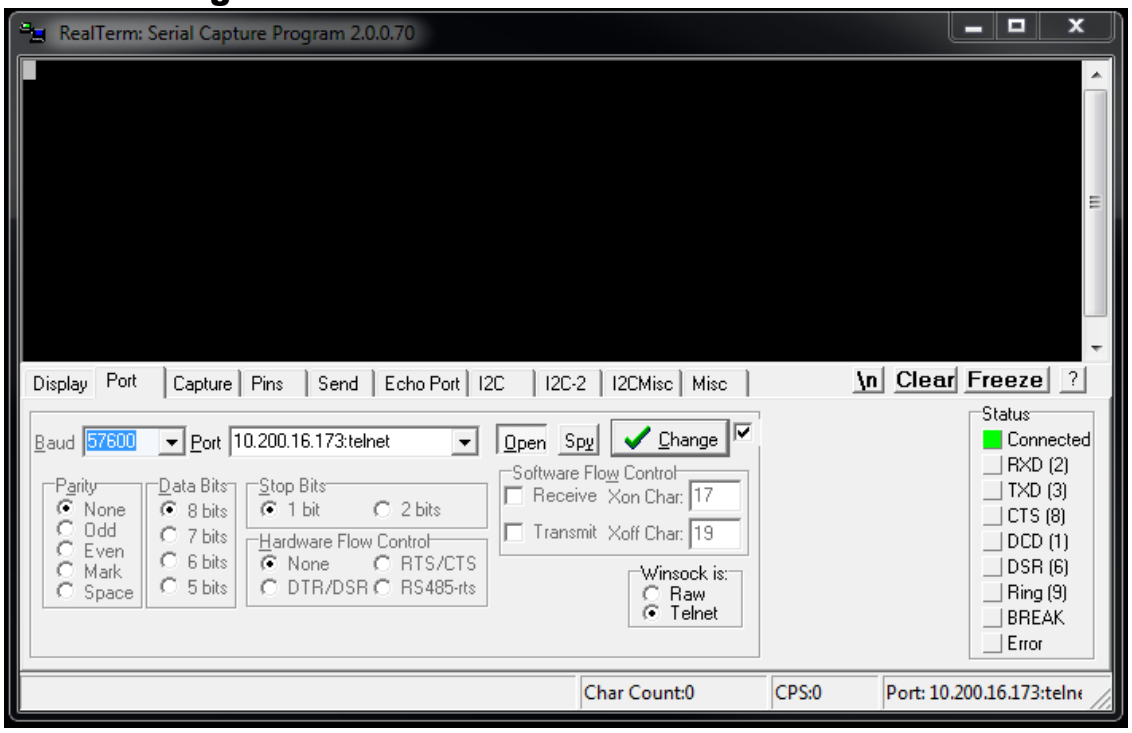


# RealTerm

## RS-232 Serial Port Configuration

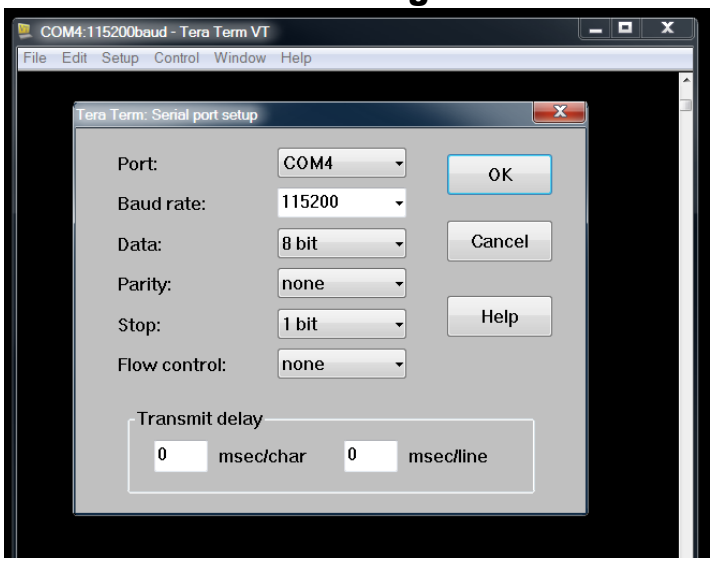



## Telnet Configuration



# Tera Term

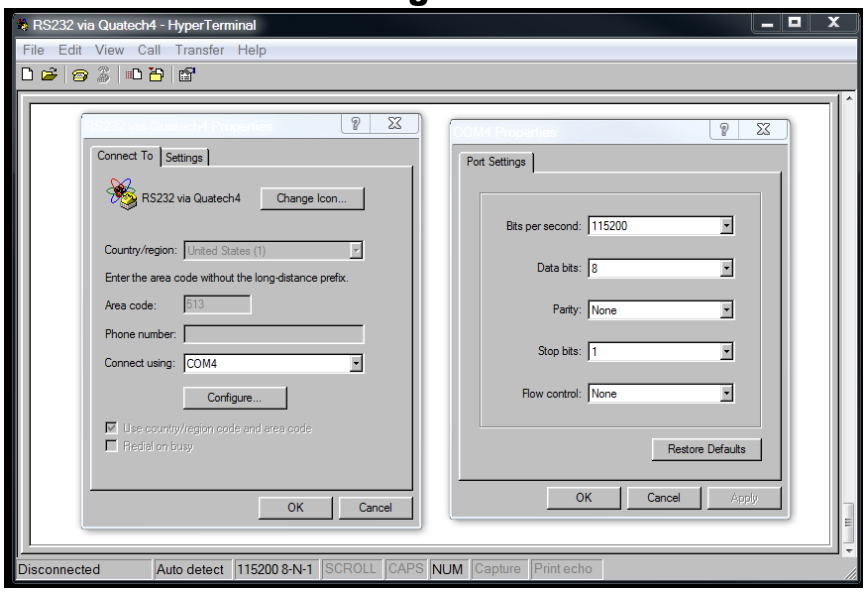
## RS-232 Serial Port Configuration




## Telnet Configuration

# HyperTerminal Private Edition

## RS-232 Serial Port Configuration




## Telnet Configuration