SmartTrak® Series 100

Mass Flow Meters and Controllers

Models: C100 and M100

INSTRUCTION MANUAL

IM-100, Revision: A2
May 2024

S SIERRA®

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IMPORTANT CUSTOMER NOTICE: OXYGEN SERVICE

Sierra Instruments, Inc. is not liable for any damage or personal injury, whatsoever, resulting from the use of Sierra Instruments standard mass flow meters or controllers for oxygen gas. You are responsible for determining if this mass flow meter or controller is appropriate for your oxygen application. You are responsible for cleaning the mass flow meter or controller to the degree required for your oxygen flow application.

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TRADEMARKS

SmartTrak® 100 Series and Dial-A-Gas® is a Registered Trademark of Sierra Instruments, Inc. Other product and company names listed in this manual are trademarks or trade names of their respective manufacturers.

SMART-TRAK® 2 NAME CHANGE

Please note that the family name of the Smart-Trak Series has been renamed from Smart-Trak® 2 to SmartTrak® 100 Series. It is the same great product, but with a new look (label).

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CHAPTER 1: INTRODUCTION

Welcome to the future of gas flow measurement!

This manual is your guide to SmartTrak. Visit the Sierra Instruments website **www.sierrainstruments.com** any time for more information about this product.

The SmartTrak instruments offer a variety of features for ease of operation. Among these features:

✓ **Dial-A-Gas®:** allows a user to change from among 10 gases while maintaining accuracy.
✓ **The Optional Pilot Module:** control electronics that offers both display and control options at the user's fingertips.
✓ **Digital Electronics**: maximum performance with minimum noise plus exceptional tuning capability.
✓ Choice of **Analog Communications Options and RS-232** with every SmartTrak instrument.
✓ **Flexible Design** with many functions that can be re-configured on-site by the user.
✓ **Compact Footprint** that allows SmartTrak to fit almost anywhere.
✓ **Wide range of sizes** for gas flow from 0.1 sccm to 1400 slpm.
✓ **And many more**

Using This Manual

This manual is organized into six chapters:

- **Chapter 1:** Introduction and Theory of Operation.
- **Chapter 2:** Installation, Plumbing & Wiring instructions.
- **Chapter 3**: Analog Operation.
- **Chapter 4**: Digital Operation with the Optional Pilot Module.
- **Chapter 5**: Digital Operation with RS-232 & SmartTrak Software.
- **Chapter 6**: Technical Support and Service.
- **Appendix A,B,C,D,E,F, and G**

Throughout this manual, we use the word *instrument* as a generic term to represent all models of Sierra Instruments' **SmartTrak Series 100** mass flow meters and controllers.

SAFETY INFORMATION

Caution and warning statements are used throughout this book to draw your attention to important information.

Warning!
This statement appears with information that is important to protect people and equipment from damage. Pay very close attention to all warnings that apply to your application.

Caution!
This statement appears with information that is important for protecting your equipment and performance. Read and follow all cautions that apply to your application.

RECEIPT OF YOUR INSTRUMENT

When receiving the instrument, carefully check the outside packing carton for damage that may have incurred during shipment. If the carton is damaged, notify the local carrier and submit a report to the factory or distributor. Remove the packing slip and check that all ordered components are present and match your specifications (as ordered). Make sure any spare parts or accessories are not discarded with the packing material. Do not return any equipment to the factory without first contacting one of Sierra's Technical Support Centers:

USA (Headquarters) Customer Service:
      TOLL FREE: 800-866-0200
      PHONE: 831-373-0200
      FAX: 831-373-4402
      EMAIL: service@sierrainstruments.com

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      PHONE: +31 72 5071400
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DEFINITIONS USED IN THIS MANUAL

The following terms are used frequently in this manual. They are presented here with their definitions for your information.

Setpoint—The command or control signal supplied to a flow controller is called its setpoint. The controller will maintain the flow at this value.

Full scale—The highest flow that an instrument will meter within its specified accuracy. It is often possible for an instrument to measure a flow beyond its full scale value, but the accuracy of this measurement may be outside of published specifications.

Purge—The SmartTrak Mass Flow Controller is supplied with the ability to open the valve far beyond the full scale position to allow them to be cleaned. This is usually accomplished by blowing clean, dry nitrogen through the instrument. When the valve is opened to this cleaning position, it is said to be in the Purge mode.

LFE—Laminar Flow Element (LFE) or bypass generates pressure drop forcing a small fraction of the total flow to pass through the sensor capillary tube.

THE CAPILLARY THERMAL OPERATING PRINCIPLE

Watch Video: www.sierrainstruments.com/CapPrinciple.

The operating principle of the SmartTrak instruments is based on heat transfer and the first law of thermodynamics. During operation process gas enters the instrument's flow body and divides into two flow paths, one through the sensor tube, and the other through the laminar flow bypass. The laminar flow bypass (often called LFE which stands for "laminar flow element") generates a pressure drop, P_1–P_2, forcing a small fraction of the total flow to pass through the sensor tube (m_1).
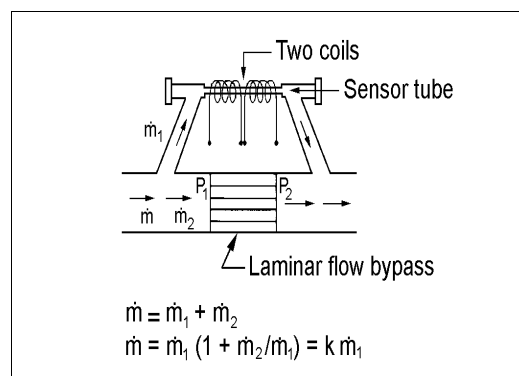
Figure 1-1. Flow Paths through the Instrument

Two resistance temperature detector (RTD) coils around the sensor tube direct a constant amount of heat (H) into the gas stream. During operation, the gas mass flow carries heat from the upstream coil to the downstream coil. The resulting temperature difference (ΔT) is measured by the SmartTrak microprocessor. From this, SmartTrak calculates the output signal. Since the molecules of the gas carry away the heat, the output signal is linearly proportional to gas mass flow.
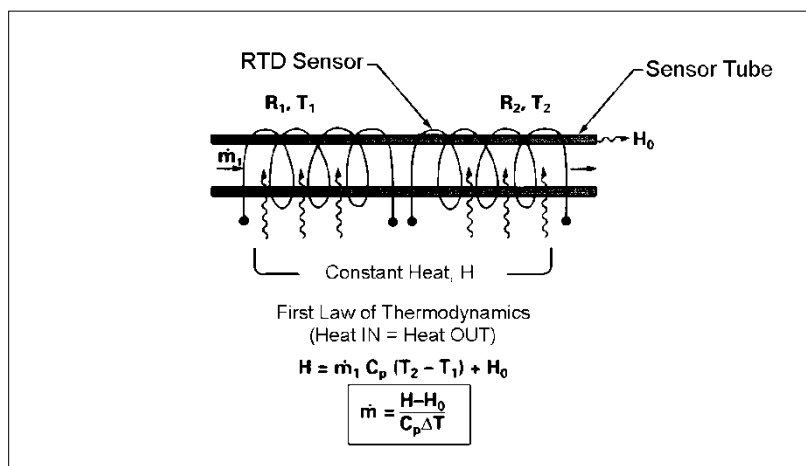
Figure 1-2. Flow Measuring Principle

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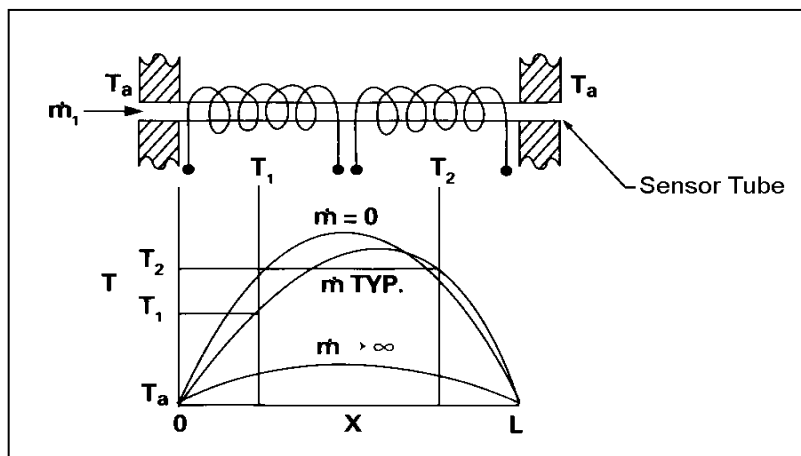
Figure 1-3. Sensor Temperature Distribution

Figures 1-2 and 1-3 show the mass flow through the sensor tube as inversely proportional to the temperature difference of the coils. The coils are legs of a bridge circuit with an output voltage in direct proportion to the difference in the coils' resistance; the result is the temperature difference (ΔT). Two other parameters, heat input (H) and coefficient of specific heat (Cp) are both constant. Through careful design and attention to these parameters, this output signal is made linear over the transducer's normal operating range (Figure 1-4). As a result, the measured flow through the sensor tube is directly proportional to the gas flow in the main body.
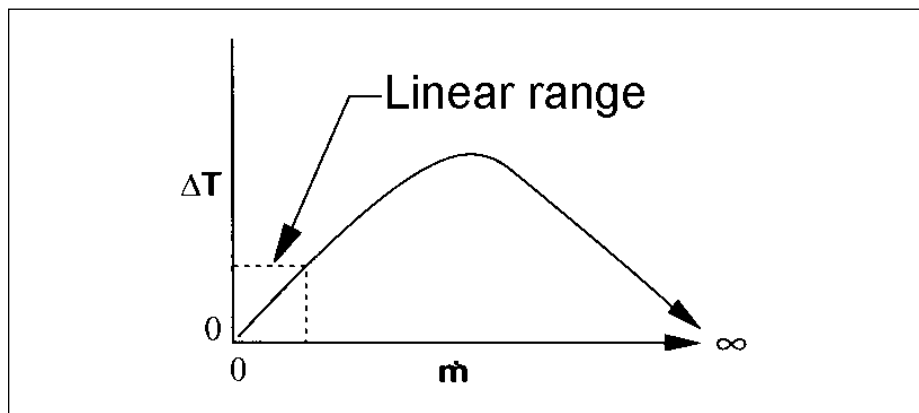
Figure 1-4. Linear Range of the Transducer's Output Signal

In the SmartTrak mass flow *controllers*, the gas which flows through the monitoring section is precisely regulated by the built-in electromagnetic valve. The normally closed valve is similar to an on/off solenoid valve, except that the current to the valve coil, and hence the magnetic field, is modulated so that the ferromagnetic valve armature, or valve

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plug, assumes the exact height above the valve's orifice required to maintain the valve's command flow (set point). The result is excellent resolution.

CHAPTER 2 INSTALLATION

Before You Begin Installation

Before installing the instrument, ensure that the installation site conforms to the specific operating parameters recorded on the instrument's Data Label. The Data Label is mounted on the back of the instrument electronics enclosure (see sample Data Labels in Figure: 2-1). This is critical because each instrument is configured for a specific application range. Please review the gas or gases, the mounting orientation, the maximum flow range(s), the inlet and outlet pressure(s), and the operating temperature(s). The line pressure should not exceed 500 psig (34 barg). The temperature should not exceed 122°F (50°C). The minimum operating temperature is 32°F (0°C) and ambient temperature is 0-50°C. If your application exceeds any of these parameters, contact your Sierra Sales Agent before installation. You may also contact one of Sierra's Technical Support Centers. FACTORY USA: TOLL FREE: 800-866-0200 or PHONE: 831-373-0200 or FAX: 831-373-4402 or EMAIL: service@sierrainstruments.com

Warning!
Injury can result if line pressure exceeds the **maximum rating of 500 psig (34 barg)** for standard SmartTrak 100.

Figure 2-1: Examples of SmartTrak Data Labels

Pre-Installation Check List

1. **Double-check to be sure that the O-ring material used in your instrument is compatible with the gas to be measured.** The O-ring material used in your

SmartTrak can be found in the Data Label. See Appendix A for a table of elastomer compatibility with a wide variety of gases.

2. **Sierra strongly recommends you install an in-line filter upstream of the instrument.** Recommended filter size: 10 micron. A 10 micron filter is available from Sierra as an accessory. See Appendix B or contact your local Sierra distributor.

3. **Do not locate the instrument in areas subject to sudden temperature changes, excessive moisture or near equipment radiating significant amounts of heat.** Be sure to allow adequate space for cable connectors and wiring.

4. **For controllers, use a properly sized pressure regulator.** Make sure the pressure regulator is not too small or too big. There can be no restrictions (such as valves, tubing or pipe internal diameters, reducers, etc.) upstream or downstream of the controller with a dimension that is less than the valve orifice diameter. To determine orifice diameter, consult the calibration certificate included with your instrument. If restricted, controller will not reach full scale.

5. **Output Signals:** The SmartTrak has two analog outputs that are linearly proportional to the gas mass flow rate, one voltage and one current. Choose from 0-20 mA or 0/0/4-20 mA for current plus one voltage signal: 0-5 VDC or 0-10 VDC or 1-5 VDC. The output signals specified at time of order will be indicated on the data label.   You may change among the current and the voltage output signal at your discretion after receipt of the instrument using the Pilot Module or the SmartTrak Software (see Chapters 4 & 5). Changing the output signals has <u>no</u> influence on the instrument's accuracy.

   NOTE: For the SmarTrak 100 plus Compod, the 0-5 VDC I/O cannot be used. Only 0/4-20 mA I/O is available.

6. **The CAT-5** connector on the side of the SmartTrak is NOT an Ethernet connector. It is for use with the optional Remote Pilot Module. Do not plug an Ethernet cable here as damage may result. Keep this connector covered if possible whenever it is not in use.

7. **The instrument has specific power supply requirements.** See the table later in this chapter for a complete listing of power requirements.

Installing the Instrument—Plumbing

SmartTrak instruments are supplied with compression, VCO®, VCR®, or female NPT process connections. To ensure a successful installation, inlet and outlet tubing should be clean prior to plumbing the instrument into the system. The shipping caps covering the inlet/outlet fittings should not be removed until immediately before installation.

Follow the installation instructions that are applicable to your instrument's process connection. Ensure that the tubing is free from burrs or sharp rims that may result from cutting.

CAUTION: Before use, all plumbing should be checked carefully for leaks, especially at the connecting fittings. All instruments are leak-tested prior to shipping. It is not a requirement to leak test your instrument. Do not use liquid leak detectors such as Snoop® to search for leaks inside or outside the SmartTrak. Instead, monitor pressure decay.
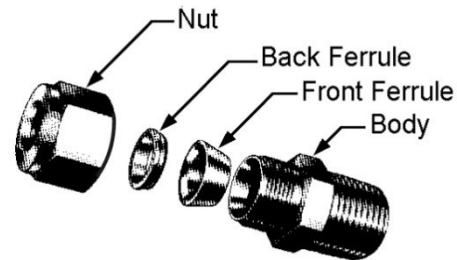
Compression Fittings

1.   Position the instrument with the flow direction arrow pointing in the direction of flow.

2.   Verify the position of the front and back ferrule. Insert the tubing into the fitting. Be sure that the tubing rests firmly on the shoulder of the fitting and that the nut is finger-tight. Scribe the nut at the six o'clock position.

3.   While holding the fitting body steady with a backup wrench, tighten the nut 1-1/4 turns, watching the scribe mark make one complete revolution and continue to the nine o'clock position. For 1/16-inch, 1/8-inch and 3/16-inch (2, 3 and 4 mm) sizes, tighten only 3/4 turns from finger-tight. **Do not over-tighten!**

4.   If you use flexible tubing (Example: Polyflow) use an "Insert" (see www.swagelok.com)

5.   Check the system's entire flow path thoroughly for leaks. **Do not use liquid leak detectors.** Instead, monitor pressure decay. Exposing the instrument to leak detector fluid may cause damage.

VCO Fittings

1.   Position the instrument with the flow direction arrow pointing in the direction of flow.

2.   Tighten the nut finger-tight, and then 1/8 turn tighter with a wrench. **Do not over-tighten!**

3.   Check the system's entire flow path thoroughly for leaks. **Do not use liquid leak detectors.** Instead, monitor pressure decay. Exposing the instrument to leak detector fluid may cause damage.

VCR Fittings

1.   Position the instrument with the flow direction arrow pointing the direction of flow.

2.   Install new gaskets that are compatible with the gas to be used.

3.   Tighten the nut finger-tight, and then 1/8 turn tighter with a wrench. **Do not over-tighten!**

4.   Check the system's entire flow path thoroughly for leaks. **Do not use liquid leak detectors.** Instead, monitor pressure decay. Exposing the instrument to leak detector fluid may cause damage.

1/4 Inch Female NPT

1.   Position the instrument with the flow direction arrow pointing the direction of flow.

2.   Apply high quality Teflon tape to the male NPT fitting. Alternatively, use a high quality paste pipe thread sealant suitable for the application and gas, and apply this compound to the inlet and outlet fittings. Avoid getting the tape or the thread sealant onto the first two threads to keep it out of your process gas.

3.   Tighten each fitting by hand. Then, tighten no more than one (1) turn. **Do not over-tighten.**

4.   Check the system's entire flow path thoroughly for leaks. **Do not use liquid leak detectors.** Instead, monitor pressure decay. Exposing the instrument to leak detector fluid may cause damage.

Rapid Gas Decompression

Under certain conditions gasses will dissolve into the elastomers used in a SmartTrak instrument. If the pressure is rapidly lowered, these gasses will not have enough time to diffuse out. This situation is known as "Rapid gas decompression". When this happens the elastomer tears from within as the gas expands in the small voids that exist in all rubbers.

The solubility of a gas into the elastomer is directly related to the amount of damage that is incurred. CO_2 is highly soluble into most common elastomers and thus has the potential to significantly damage said elastomers during Rapid gas decompression. Additionally, the higher the pressure of the CO_2 gas the more soluble it becomes and the easier it is for the CO_2 molecule to fit inside the small voids in the elastomer.

For this reason, special precautions need to be taken for use with CO_2. When you order the instrument, Sierra can equip it with 90D Viton® O-rings. For controllers, Sierra offers ValFlex™ valve seats that are more resistant.

Sierra recommends avoiding depressurizing C100 CO_2 units if possible. If depressurization is necessary, Sierra recommends performing said depressurization over a long time period (multiple hours or days, not minutes) in order to reduce the damage to elastomers caused. Reducing the pressure drop of the depressurization will also reduce the damage due to rapid gas decompression.

Installing your Instrument—Mechanical Mounting

Mounting your Instrument

The base plate or bottom of the instrument has 4 mounting holes. Two are SAE thread and two are metric thread. For location and dimensions, please see Appendix A.

Your SmartTrak instrument is made from premium 316 stainless steel. As a result, it may require substantial mounting brackets to properly support its weight. Exercise caution when installing to avoid damage or injury.

Mounting the Optional Remote Pilot Module

If you have the optional Remote Pilot Module control unit, you have several mounting options.

1. **Wall or Panel mounting**—your Remote Pilot Module may be mounted to a flat surface using the supplied plate and 2 special "shoulder" screws. Simply screw the shoulder screws into the plate. Then, attach the plate to the wall by driving 2 screws (not included) through the 2 large central holes. **MAKE SURE THE UP ARROW IMPRINTED ON THE MOUNTING BRACKET POINTS UPWARD.** Your Remote Pilot Module will slip onto the shoulder screws. Push against the plate and then down. To remove, push up and pull. Attach the CAT-5 cable to the socket on the bottom of the Remote Pilot Module.

2. **Rack mounting**—to mount your Remote Pilot Module to a standard 19" laboratory rack, first purchase a "blank" panel from your industrial supplier. Decide where the Remote Pilot Module will be attached, then follow the procedure listed above for wall mounting. When you are ready, insert the CAT-5 cable into the socket in the Remote Pilot Module.

3. **Desktop mounting**—the Remote Pilot Module will sit on a desk in a fashion that makes it convenient to view and operate. Insert the CAT-5 cable into the socket in the back of the Module. Use the cable as a "kickstand." Gently bend the cable to recline the Remote Pilot Module to an angle suitable for easy viewing.

Alternately, you can lay the Remote Pilot Module on its back and insert the CAT-5 cable into the socket in the bottom.

Installing your Instrument—Electrical Connections

All electrical connections for your SmartTrak instrument are made on the left (inlet) side panel. See Figure 2-2: SmartTrak Connections below for the location of all connections. **Note that the CAT-5 connector is not an ethernet connector.**

CAT 5
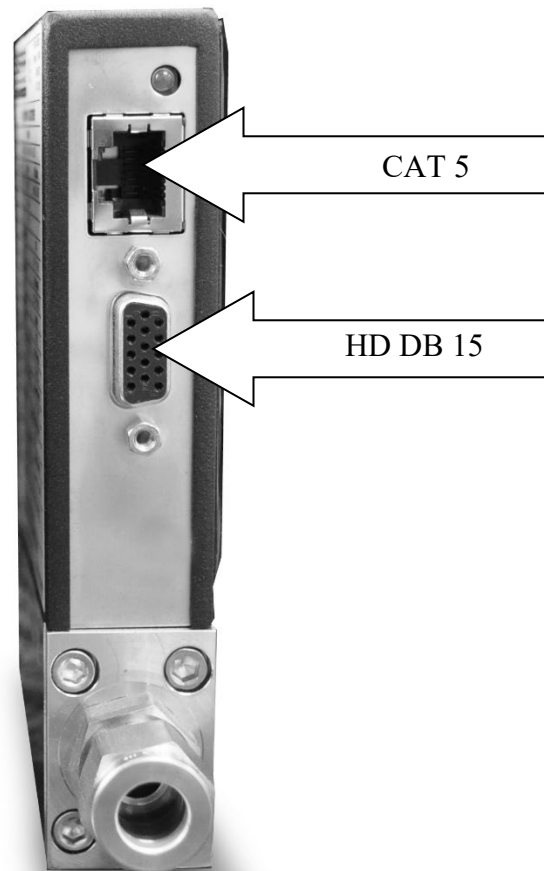
HD DB 15

Figure 2-2: SmartTrak connections

SmartTrak is provided with a high density 15-pin D Connector called an "HD DB-15" located on the side of the enclosure and either one of our optional pre-assembled communications cables or an empty mating connector. Power must be supplied to the HD DB-15 connector. Other features may be accessed there as well. The pin numbers and assignments for the HD DB-15 connector are shown in Figure 2-3: HD DB-15 Connector Pin Configuration (on the instrument). The corresponding colors of the optional communication cable wires and the functions of each are listed in Figure 2-4: Wiring Definitions for Optional Communication Cable. The connections for input power, analog output signal and analog input signal (controllers only) are all made at the HD DB-15 connector. There is a second copy of these 2 figures in Appendix D for your convenience

Figure 2-3: HD DB-15 Connector Pin Configuration (on the instrument)

Figure 2-4: Wiring Definitions for Optional Communication Cable

Pin #	Wire Color in Cable	Function
1.	Brown	Analog Ground/**Output**
2.	Red	0-5 VDC Output (or 0-10, 1-5 VDC)
3.	Orange	Analog Ground/**RS232**
4.	Pink	Valve Override Purge
5.	Yellow	Power Return (-)
6.	Green	Power Input (+)
7.	Green/White	RS-232 Transmit (out)
8.	Blue	Setpoint
9.	Purple	Not Used
10.	Gray	Analog Ground/**Setpoint**
11.	White	Reference Voltage (5 VDC External Setpoint & Valve Purge)
12.	Black	Valve Override Close

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13.	Brown/white	RS-232 Receive (in)
14.	Red/white	0/4-20 mA Output
15.	Red/Black	Not Used
	Shield Wire (no insulation)	Chassis (Earth) Ground

NOTE: Pins 1, 3, and 10 are connected together inside the instrument. Do not tie these grounds together outside the instrument. Must have one connection per analog ground. Recommended use listed.

Instrument Power:

The SmartTrak requires a 15-24 VDC power supply. If you are using the power supply supplied by Sierra, connect it to the 15-pin HD DB-15 connector on the side of the instrument. If you are supplying your own power source, it must be a regulated 15-24 VDC with ripple not to exceed 100 mV peak-to-peak. It must be capable of producing the current specified for the appropriate voltage shown in Figure 2-5: Power Supply Requirements. Apply power as follows: positive (+) to the green (pin 6) and negative (-) to the yellow (pin 5) wires. The instrument is polarity sensitive. If you reverse this wiring, the instrument will not be damaged, but it will not function.

Instrument Grounding:

The SmartTrak has very high levels of RFI and EMI shielding built into the metal electronics cover (meets or exceeds the CE Standard EN 61326-1; 2006). To maintain the integrity of this CE rating, it is critical that a path be provided for any residual internal noise to exit the instrument or it may register on the outputs. Grounding provides this path.

To properly ground your instrument, secure the chassis to solid earth ground using the mounting holes on the bottom of the flow body. If the instrument will be used without permanent mounting (on a laboratory bench, for instance) then, using the provided cable, connect the shield wire (no insulation) to earth ground in your facility. If you purchased a Sierra power supply, a ground wire is provided for your convenience.

Figure 2-5: Power Supply Requirements

Instrument Type	Recommended Input Voltage	Minimum Current Required (mA)
M100L Meter	15-24 VDC ($\pm$ 10%)	230
M100M Meter	15-24 VDC ($\pm$ 10%)	230
M100H Meter	15-24 VDC ($\pm$ 10%)	230
C100L Controller	24 $\pm$ 10% VDC	500
C100M Controller	24 $\pm$ 10% VDC	800
C100H Controller	24 $\pm$ 10% VDC	1260

NOTE: The Compod™ adds an additional 100mA to the ST2 current ratings.

CAUTION: This instrument is not a loop-powered device! Do NOT apply instrument power to the 0/4-20mA output or setpoint connections. The 0/4-20mA output is self-powered, do not apply any external voltage. Apply instrument power only to pins 5 & 6 of the 15 pin D-connector, refer to the wiring diagram

Analog Output Signals:

- **Output Signal—Voltage:** Measure the voltage output signal across the red (pin 2) wire and any of the analog grounds: brown (pin 1), orange (pin 3) or gray (pin 10). The minimum load is 1000 Ohms. We recommend pin 1. DO NOT USE THE SAME ANALOG GROUND FOR CURRENT OUTPUT, SETPOINT OR RS232.

- **Output Signal—Current:** Measure the current output signal, 0/4-20 mA or 0-20 mA, across the red/white stripe (pin 14) wire and any of the analog grounds: pin 1, 3, or 10. The maximum load is 500 Ohms. We recommend pin 1. DO NOT USE THE SAME ANALOG GROUND FOR VOLTAGE OUTPUT, SETPOINT OR RS232.

For Mass Flow Controllers, the following analog features are also available at the HD DB-15 connector:

- **Setpoint:** To transmit an analog setpoint, supply the voltage or current signal (check the data label and/or setting) across the blue (pin 8) wire and pin 10.

- ▪ **Valve Close**: To force the valve closed, connect the black (pin 12) wire to pin 10

- ▪ **Purge:** To force the valve to its maximum open position which we call "Purge," connect the pink (pin 4) wire to the white (pin 11) wire. Note that this will allow much greater flow than the rated full-scale value.

For Digital Communication Using Your Personal Computer:

You can communicate with your instrument using the SmartTrak Software package and your PC running the Windows operating system. Simply connect the light green (pin 7) wire, the brown/white stripe (pin 13) wire and one of the analog grounds (pin 1,3, or 10) to a standard DB-9 connector according to Figure 2-6: Digital Communication.

Figure 2-6: Digital Communication

RS-232 Transmit (pin 7)   to   DB-9 pin #2

RS-232 Receive (pin 13)   to   DB-9 pin #3

Analog ground (pin 3)   to   DB-9 pin #5

NOTE: Transit and Receive may need to be reversed, depending on which type of device or cable is connected. (No damage will result—attempt communication after reversal.

With the connections in Figure 2-6 in place, plug the DB-9 connector into an appropriate serial port on your PC.

To minimize the potential for RF interference, it is recommended to shield these wires. Use a metal DB-9 connector and connect one end of the shield to the DB-9 shell and the other end to the outer shell of the SmartTrak HD DB-15 connector.

CAUTION: The CAT-5 connector on the side of the SmartTrak NOT an Ethernet connector. It is for use with the optional Remote Pilot Module or CRN cable. Do not plug an Ethernet cable here as damage may result.

CHAPTER 3: ANALOG OPERATION

Your SmartTrak instrument may be operated in three different ways:

THREE CONTROL OPTIONS

A. Analog Input/Output Operation (This Chapter): Using analog input/output signals at the 15-pin mini-D connector.

B. Digital Operation with Pilot Module (Chapter 4): Using the optional Pilot Module.

C. Digital Operation with RS-232 and SmartTrak Software (Chapter 5): Using the RS-232 link, the supplied SmartTrak Software package, and a PC-style computer running Windows operating system.

This chapter will discuss the first of these—Analog Operation. Please see subsequent chapters for other options.

Regardless of control options, the standard output for all SmartTrak instruments are two linear analog output signals corresponding to 0% to 100% of the mass flow full-scale range. Please note that one of these output signals is a current signal of either 0/4-20 or 0-20 mA. The other is a voltage signal of 0-5 VDC, 0-10 VDC or 1-5 VDC. You can choose any combination of these signals at any time in your facility.

For mass flow controllers, one input signal of 0/4-20 mA, 0-20 mA, 0-5 VDC, 0-10 VDC or 1-5 VDC (selectable by user) may be chosen to set the gas mass flow rate to any desired value within the range of the device. This input signal must be a direct linear representation of 0% to 100% of the desired gas mass flow full-scale value. For the location of these signals on the HD DB-15 connector, refer to Figure 2-4 or Appendix D**.**

Analog Operation, Mass Flow Meter

After your instrument is installed and the system has undergone a complete leak check as discussed in detail in Chapter 2, you are ready to supply power.

Power Your Instrument: Provide adequate power per Figure 2-5. Apply power using Sierra's power supply or your own power source. The green LED at the top of the inlet side will light to confirm power. If your instrument has a Pilot Module, it will begin its start-up cycle. See Chapter 4 for details on Pilot Module operation. ___**NOTE:**___ It is highly recommended you connect power to the SmartTrak, and then power your supply (plug into wall or switch on). The opposite may cause the unit to take longer to power on. Let the instrument warm up for at least 15 minutes for optimal performance.

Your SmartTrak instrument is now ready for use!

Analog Operation, Mass Flow Controller

After your instrument is installed and the system has undergone a complete leak check as discussed in detail in Chapter 2, follow these steps:

1. **The valve will remain closed until power is supplied.** See Chapter 2 for wiring instructions. Remember that the valve in the SmartTrak is not a positive shut-off device. When power is applied, the flow control valve will operate per any instructions it receives. When the SmartTrak is delivered, the valve will be in the Automatic (Normal) state and the Pilot Module or analog signal will provide the correct zero setpoint reference for the instrument. As a result, the valve will be closed. However, upon subsequent power-ups, the valve will return to the state it was in the last time the instrument was operated.

CAUTION: If you do not know the value of the setpoint or the valve state given to the SmartTrak when it was last operated, you must assume that the valve will open when power is applied. Take necessary precautions. You may use the Pilot Module or the SmartTrak Software to check the setpoint or the valve state currently on your instrument. See Chapter 4 or Chapter 5 for information on Setpoint and Valve State.

2. **Power Your Instrument:** Provide adequate power per Figure 2-5. Apply power using Sierra's power supply or your own power source. The green LED at the top of the inlet side will light to confirm power. If your instrument has a Pilot Module, it will begin its start-up cycle. See Chapter 4 for details on Pilot Module operation. ***NOTE:*** It is highly recommended you connect power to the SmartTrak, and then power your supply (plug into wall or switch on). The opposite may cause the unit to take longer to power on. Let the instrument warm up for at least 15 minutes for optimal performance.

3. **Adjust the controller setpoint to the desired flow rate by supplying an appropriate signal (mA or VDC).** The effective control range of the unit is 2% to 100% of the calibrated full scale flow range. Automatic shut-off occurs at 1.9% of the factory full scale calibrated range unless specifically modified at time of order. SmartTrak will immediately begin accurately monitoring and controlling the gas mass flow rate. Let the instrument warm up for at least 15 minutes for optimal performance.

4. **After 30 minutes, if your zero reading and/or calibration are off (i.**e. show flow at zero), we recommend that you perform the re-zeroing procedure. Refer to page 45 "Zero Meter Screen" for instructions.

Your SmartTrak instrument is now ready for use!

SmartTrak Features

Setpoint Adjustment

The setpoint (command) input signal you supply to SmartTrak must be a direct linear representation of 0% to 100% of the mass flow full-scale value. Apply the setpoint signal from pin 8 to any of the analog grounds (see Chapter 2 for wiring details). A setpoint value of 0 VDC or mA (or 1 VDC or 4 mA) will regulate the flow to 0% and a setpoint value of 5.00 VDC (or 10 VDC or 20 mA) will adjust the flow to 100% of the instrument's full scale range.

When the setpoint (command) signal is applied, the flow controller will reach the setpoint value within two seconds to within ±2% of the selected flow rate.

CAUTION: *DO NOT LEAVE A SETPOINT APPLIED FOR AN EXTENDED PERIOD OF TIME TO A CONTROLLER WHEN THE GAS SUPPLY IS SHUT OFF OR BLOCKED*. Damage may result and the instrument will become hot to the touch. Instead, see below for use of the "Valve Close" feature which allows you to disable the valve while maintaining the setpoint signal. This may be set by the Pilot Module, the SmartTrak Software, or an external analog signal.

Changing the Output or Setpoint Signals

To modify the analog output or setpoint signals (from 0/4-20mA to 0-10Vdc, for example), you must use the Pilot Module or the SmartTrak Software. The data label will indicate the form these signals had when the instrument was last calibrated. We strongly recommend that you adapt the data label if the configuration is changed for future reference. See Chapter 4 or 5 for the necessary procedure.

Over-Range Condition

If the mass flow rate exceeds the full-scale range listed on the SmartTrak data label (see samples on page 2-1), the output signal will measure above full-scale. However, the device has not been calibrated for flows in excess of the calibrated full scale value and the value will be both non-linear and inaccurate if an over-range condition exists. Please be aware that the analog outputs can exceed full scale by as much as 20%, or more.

Once the over-range condition has been removed, it may take up to 30 seconds for the SmartTrak to recover and resume normal operation. An over-range condition will <u>not</u> harm the instrument.

Manual Valve Override—Valve Close

Manual valve override is provided for all Sierra mass flow controllers. This feature includes both a valve close command and a valve maximum open command (called purge). When the valve is directed to close or to purge, it will no longer respond to a setpoint command.

FOR VALVE CLOSE: connect pin 12 to analog ground

Remember that the valve in the SmartTrak is not a positive shut-off device. The Controller will return to normal automatic operation about 4 seconds after pin 12 is left floating.

Manual Valve Override—Valve Purge Function

The purge function opens the controller valve completely for the purpose of quickly flushing unwanted gas from the flow path. When the valve is opened for purging, it allows flows far in excess of the rated full scale of the controller.

FOR VALVE PURGE: connect pin 4 to pin 11.

CAUTION: PURGE MODE ALLOWS FAR MORE GAS TO FLOW THROUGH THE CONTROLLER! BEFORE USING VALVE PURGE OPERATION, INSURE PROPER DOWNSTREAM CAPACITY AND VENTILATION.

IMPORTANT NOTES ABOUT PURGING

Purging Non-Reactive Gases:

Purge your SmartTrak with clean, dry nitrogen for a minimum of two hours.

Purging Reactive Gases:

One of the following methods may be used:
- ❖ Cycle purge. This is done by alternately evacuating and purging the instrument for 2 to 4 hours with clean, dry nitrogen.
- ❖ Purge the instrument with clean, dry nitrogen for 18 to 24 hours.
- ❖ Evacuate the instrument for 18 to 24 hours.

IMPORTANT SAFETY NOTES ABOUT PURGING

WARNING: When toxic or corrosive gases are used, purge unit thoroughly with inert dry gas before disconnecting from the gas line to prevent personnel from being injured when coming in contact with the instrument.

WARNING: If an instrument used with a toxic or corrosive gas is returned to the factory, a Material Safety Data Sheet (MSDS) must be enclosed & attached to the outside of the box to alert Sierra personnel of the potential hazard. Also, make sure the inlet & outlet are securely sealed.

CHAPTER 4: Digital Operation with Pilot Module

Your SmartTrak instrument may be operated in three different ways:

THREE CONTROL OPTIONS

A. **Analog Input/Output Operation (Chapter 3):** Using analog input/output signals at the HD DB-15 connector.

B. **Digital Operation with Pilot Module (This Chapter):** Using the optional Pilot Module.

C. **Digital Operation with RS-232 and SmartTrak Software (Chapter 5):** Using the RS-232 SmartTrak Software package and a computer running the Windows operating system.

This chapter will discuss the second of these—Digital Operation with the optional Pilot Module. Please see alternate chapters for other options.

Although you have chosen to use the optional Pilot Module, please note that all the Analog control functions are still available on your instrument. Consult Chapter 3 for details on Analog operation. Also, computer control using the RS-232 communication is available. See Chapter 5 for details on operation with a computer.

CAUTION—If RS-232 digital communication is to be used in conjunction with the Pilot Module, the HD DB15 connector must be properly wired with a three wire serial DB9 cable to your computer. Often, this is done with the same HD DB15 that supplies power to your instrument. You can run both RS-232 communication and Pilot Module communications in parallel, but the unit will only respond to one set of commands at a time. DO NOT attempt to control the unit simultaneously with both the Pilot Module and the computer, this can lock up the unit.

Introduction to Pilot Module Features and Capabilities

The optional Pilot Module functions as both display and a control unit for your SmartTrak instrument. The standard Pilot Module is available mounted directly on the face of your instrument or as a handheld / remote mountable control interface attached to the SmartTrak via a detachable cable.

If your instrument has a standard Pilot Module mounted locally on the face of the unit, no additional set-up is required. See picture below.

On the other hand, if your instrument has a Remote Pilot Module, attach one end of the included Category 5 (CAT 5, also called RJ-45) connecting cable into the jack at the top of the instrument's left side, immediately above the HD DB-15 connector.
Next, place the other end into one of the two matching jacks on the Pilot Module. For your convenience, Sierra has provided two jacks—one on the back and one on the bottom of the Remote Pilot Module. You may use whichever jack is most convenient for your application as they both have identical functions.

The Pilot Module includes a large LCD graphic display screen and six buttons. The LCD will show a variety of information and the buttons can be used to view and modify this information. The convenient buttons are:

<div align="center">

Left arrow

Right arrow

Up arrow

Down arrow

Enter button

Escape button

</div>

These are shown in the photo below:
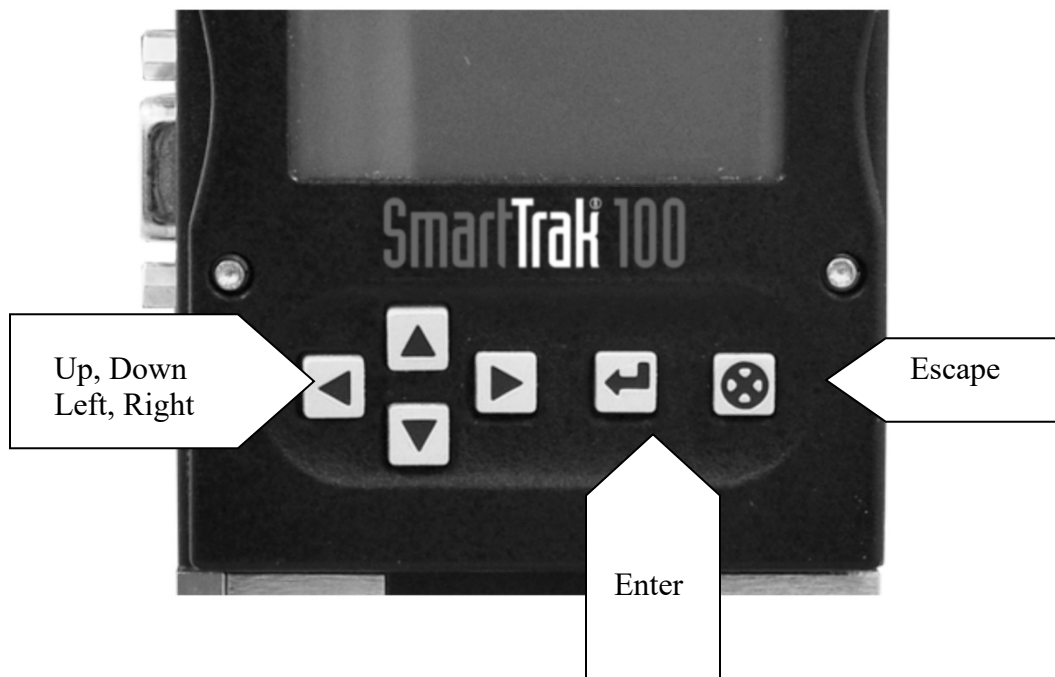
Pilot Module Operation, Mass Flow Meter

After your instrument is installed and the system has undergone a complete leak check as discussed in detail in Chapter 2, follow these steps:

Caution!
The SmartTrak is not a loop-powered device. Do not apply power to the 4-20 mA outputs.

1. **Power Up Your Instrument:** Apply power to your instrument. See Chapter 2, Figure 2-5: Power Supply Requirements. When power is first applied, the Pilot Module will display:

<div align="center">

Version
2.04X
Read Parameters

</div>

Assuming no gas is flowing, after another 5-10 seconds the display will read:

<div align="center">

Mass Flow
0.000 sl/m
Air

</div>

NOTE: If gas is flowing the Pilot Module will immediately begin to accurately display the gas mass flow rate on the LCD panel. If you have chosen alternate units or another gas, the display will show the selected units instead of the above.

2. **Open the gas supply:** SmartTrak is now ready to monitor the gas mass flow rate. Let the instrument warm up for at least 15 minutes for optimal performance.

3. **After 30 minutes, if your zero reading and/or calibration are off (i.**e. show flow at zero), we recommend that you perform the re-zeroing procedure. Refer to page 45 "Zero Meter Screen" for instructions.

Your SmartTrak instrument is now ready for use!

Pilot Module Operation, Mass Flow Controllers

After your instrument is installed and the system has undergone a complete leak check as discussed in detail in Chapter 2, follow these steps:

1. **The valve will remain closed until power is supplied.** See Chapter 2 for wiring instructions.

CAUTION: Remember that the valve in the SmartTrak is not a guaranteed positive shut-off device. For dangerous applications, Sierra recommends use of an external shut-off safety valve.

When power is applied, the flow control valve will operate per the instructions it receives from the Pilot Module. When the SmartTrak is delivered, the valve will be in the Automatic (Normal) state and the Pilot Module will provide the correct zero setpoint reference. As a result, the valve will be closed. However, the valve will return to the state it was in the last time the instrument was operated.

WARNING: If you do not know the setpoint or the valve state of the Mass Flow Controller before it was shut down, you must assume that the valve will open when power is applied. *TAKE NECESSARY PRECAUTIONS.*

2. **Power Up Your Instrument:** Apply power to your instrument using Sierra's power supply or your own input power source. See Chapter 2, Figure 2-5: Power Supply Requirements. When power is first applied, the Pilot Module will display:

<div align="center">

**Version
2.04X**
Read Parameters

</div>

If no gas is flowing, after another 5-10 seconds the display will read:

Mass Flow
0.000 sl/m
Air

NOTE: If gas is flowing and the Pilot Module has a setpoint greater than zero, it will immediately begin to accurately display the gas mass flow rate on the LCD panel. If you have chosen alternate units or another gas, the display will show the selected units instead of those above.

3. **Open the gas supply.** SmartTrak is now ready to monitor and control the gas mass flow rate. The display will show 0.000 until it is given a setpoint. Let the instrument warm up for at least 15 minutes for optimal performance.

4. **After 30 minutes, if your zero reading and/or calibration are off (i.**e. show flow at zero), we recommend that you perform the re-zeroing procedure. Refer to page 45 "Zero Meter Screen" for instructions.

Your SmartTrak instrument is now ready for use!

CAUTION: DO NOT LEAVE A SETPOINT APPLIED FOR AN EXTENDED PERIOD OF TIME TO A CONTROLLER WHEN THE GAS SUPPLY IS SHUT OFF OR BLOCKED. Damage may result and the instrument will become hot to the touch. Instead, see below for use of the "Valve Close" feature which allows you to disable the valve while maintaining the setpoint signal. This may be set by the Pilot Module, the SmartTrak Software, or an external analog signal.

Using the Pilot Module Menus & User Interface

The features of the Pilot Module can be considered in three groups:

1 **Upper Level Screens**: display information (no password is required to view this information). These include:
   ❖ Mass flow rate
   ❖ Gas (10 options pre-programmed)
   ❖ Engineering units (mass per unit time)
   ❖ Current Setpoint with units
   ❖ Source of Setpoint (analog or digital and type)

❖   Valve operation mode (normal, valve close or purge)
❖   Current meter full scale value with units (user selectable)

2 **Lower Level Screens**: permit changes to instrument operation. They are password protected. These include:

❖   Setpoint value
❖   Engineering units
❖   Gas
❖   Valve operation
❖   Source of the setpoint signal
❖   Form of the output signals
❖   Full scale of the instrument
❖   Password
❖   Zero
❖   Span

3 **Maintenance Features**:

❖   **Re-boot the SmartTrak microprocessor.** Press the LEFT ARROW, DOWN ARROW, ENTER, AND ESCAPE keys *at the same time*.

❖   **Move the decimal point.** Navigate to the "change the setpoint" menu. Press ENTER to make one of the digits flash. While it is flashing, press ESCAPE at the same time you press LEFT ARROW or RIGHT ARROW.

❖   **Return all parameters to the factory default values**. Navigate to the "Change the Setpoint" menu. Press LEFT ARROW, UP ARROW, and ENTER at the same time. Choose "yes" to restore factory default settings.

❖   **If you are trying to navigate using the pilot but the message appears, "Must be in Pilot Mode,"** use the LEFT ARROW from this screen to navigate to the "Change Setpoint Source" and change to "Pilot / RS-232." Escape and try again.

Map of the Pilot Module Interface

The Pilot Module user interface is presented below in a graphical format. Once you have some familiarity with the user interface, you may find you want to make a copy of this and keep it with the instrument for reference. You can find a larger version of this Flow Chart in Appendix G.
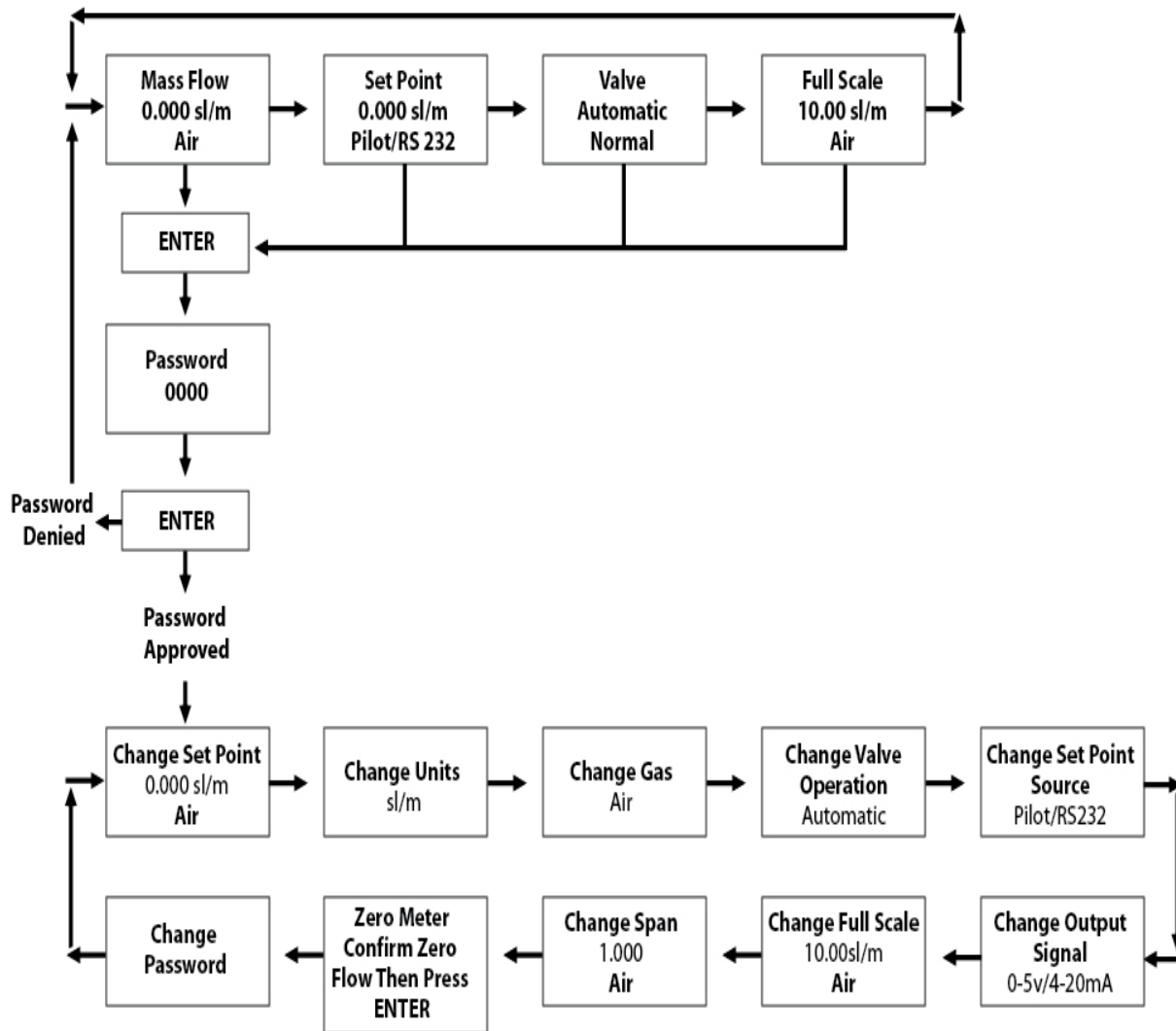
The seven **Upper Level Screens** display a variety of information. You are able to move between the screens by pressing the left or right arrows. No password is required for the Upper Level Screens.

Mass Flow Screen

When the instrument is powered up, or whenever the escape button is pressed, it always returns to the Mass Flow Screen. This screen displays the mass flow rate, the engineering units and your gas choice. It looks something like this:

<div align="center">

Mass Flow

0.000 sl/m

Air

</div>

Setpoint Screen

Pushing the right arrow takes you to the Setpoint Screen. The Setpoint Screen displays the current setpoint given to the controller, the engineering units and the source of the setpoint signal.

The source of the setpoint can be:
- Pilot Module/RS-232
- 0/4-20 mA
- 1-5 Vdc
- 0-5 Vdc
- 0-10 Vdc

For operation with the Pilot Module, the display will look something like this:

<div align="center">

Setpoint
10.00 sl/m
Pilot Module/RS-232

</div>

If this screen does not show "Pilot Module/RS-232" at the bottom, you will not be able to give the controller a setpoint command from the Pilot Module because the instrument is waiting for an analog setpoint. See section below titled "Change Setpoint Source Screen" to change the source of the setpoint signal. Alternately, you may supply an analog setpoint to the HD DB-15 connector (see Chapter 3).

Valve Position Screen (Mass Flow Controllers only)

Pushing the right arrow again takes you to the Valve Position Screen, if you have a Mass Flow Controller. This screen will display the current state of the SmartTrak valve.

The state of the valve can be:
1. Closed (Remember that the SmartTrak is not a positive shut-off device).
2. Purge--Maximum Open (recommended 120% of the calibrated full scale value, but can be much more and can be dangerous)
3. Automatic (the normal position, where the controller responds to a setpoint signal).

WARNING: The flow rate in Purge is much greater than the calibrated full scale value and as a result can be dangerous.

For normal operation of the flow controller, this screen should display:

Valve
Automatic
Normal

If this is visible, the instrument will automatically control flow as soon as a setpoint is given to it. If this screen displays Closed or Purge, the instrument has been placed into an override position and it will not respond to any setpoint signal. The valve state may be changed using the "Change Valve Operation" as described on page 4-16.

Full Scale Screen
Pressing the right arrow again takes you to the Full Scale Screen. This screen displays the current full scale value of the instrument with engineering units. It also displays the gas. Note that this is not necessarily the factory calibrated full scale value. The screen will display:

Full Scale
10.00 sl/m
Nitrogen

To change the full scale value, see the section below titled "Change Full Scale Screen." Pressing the right arrow again takes you back to the Mass Flow Screen.

Lower Level Screens (Changing Parameters)

Getting to the Lower Level Screens:

Your instrument is password protected so that unauthorized personnel will be unable to change the operating parameters of SmartTrak. To enter the Lower Level Screens at any time you must first supply the correct password.

Password Screen: By pressing the "enter" key from any of the Upper Level Screens you will come to the Password Screen. (If you do not know if you are in an Upper Level Screen, press escape and you always automatically go to the Mass Flow Screen in the Upper Level) The display will show:

<div align="center">

Enter Password

0000

</div>

The first digit will blink. At this point, you must enter the correct password to gain access to the Lower Level Screens.

✓ **If the instrument is being operated for the first time or if no password has ever been set on the instrument***:* You can use the factory default password. The factory default password is "0000." To proceed to the Lower Level Screens by using the factory default password, simply press the "enter" key a second time.   If you want rapid access to permit regular changes to your instrument and you do not desire a password, this is the fastest way to enter the lower level.

✓ **If You Have a Password***:* If you have already set a password, enter it now. To enter the password, push the up arrow to increase the blinking digit or the down arrow to decrease the blinking digit. To move to the next digit, press the left or right arrow and repeat the process. When you have selected your four digit password, press the enter key.

✓ **If You Want to Set a New Password:** If you want to change the password, you must first get to the Lower Level Screens. Proceed by entering your known password or if no password has ever been set on the instrument, us the factory default password. Follow the instructions in the "Change Password Screen" section found later in this chapter.

If the password you have entered is correct, you will enter the Lower Level at the Change Setpoint Value Screen.

If the password is not correct, the display will show:

<div align="center">

Access Denied

Press any button

To continue

</div>

When you press any button, you will return to the Mass Flow Screen in the Upper Level. Press the "enter" key to try again.

LOST PASSWORDS & GENERAL CUSTOMER SERVICE: If you lose your password, it will be necessary to contact one of Sierra's Technical Support Centers.

> **Email Customer Service:** service@sierrainstruments.com

> **FACTORY USA Customer Service:**
> TOLL FREE: 800-866-0200
> PHONE: 831-373-0200
> FAX: 831-373-4402
> EMAIL: service@sierrainstruments.com

> **European Customer Service:**
> PHONE: +31 72 5071400
> FAX: +31 72 5071401
> EMAIL: service@sierra-instruments.nl

> **Asia Customer Service:**
> PHONE: **+ 8221 5879 8521**
> FAX: **+8621 5879 8586**
> EMAIL: www.sierra-asia.com

Making Changes Using the Lower Level Screens:

The ten Lower Level Screens are at the heart of Dial-A-Gas®, allowing you complete control of your SmartTrak instrument. It is possible to make several changes on different Lower Level Screens before exiting.

For example, you could change between one of the ten pre-programmed gases, change the engineering units, and change the setpoint all in one visit to the Lower Level Screens. The SmartTrak will make each adjustment as you complete it. At any time, you may press the escape button to return to the Upper Level.

Change Setpoint Value Screen

This screen is the entry point to the Lower Level. As soon as a correct password is entered, you will arrive here. If you are already in the Lower Level Screens, push the right or left arrow until you reach the Change Setpoint Value screen. The display will show:

<div align="center">

Change Setpoint
00.00 sl/m
Air

</div>

This is the position where you can change the setpoint value of the mass flow controller. To make a change to the displayed value, press the enter key. The first number in the display will blink. Use the up and down arrows to change the value of this digit or the left and right arrows to move to another digit. For example, if you wish to enter a setpoint of 12.5 sl/m, push the "up" arrow once when the first digit is blinking. You will see:

<div align="center">

Change Setpoint
10.00 sl/m
Air

</div>

Next, press the "right" arrow so that the second digit blinks. Push the up arrow twice. You will now see:

<div align="center">

Change Setpoint
12.00 sl/m
Air

</div>

Press the right arrow again. The first digit after the decimal point will now blink. Press the up arrow 5 times until you see:

<div align="center">

Change Setpoint
12.50 sl/m
Air

</div>

Now that you have made your selection, press the enter key. The display from our example will show:

<div align="center">

Change Setpoint
12.50 sl/m
Air

</div>

If you are finished or wish to observe the changes you have made on the LCD panel, press the escape key to return to the Upper Level Mass Flow Screen.

If you prefer to make additional changes, use the left and right arrow keys to move to other Lower Level Screens.

Caution!
The SmartTrak will not allow you to enter a setpoint greater than the current full scale value set on the instrument.

Note: If you enter a Setpoint that exceeds the full scale value (displayed in the "Full Scale" screen in the Upper Level), the SmartTrak will automatically modify this value to equal the current full scale value. For example, if the current full scale value of your instrument is 10 slpm and you have entered a setpoint of 15 slpm, the SmartTrak will modify your setpoint to 10 slpm when you implement the change. The Setpoint Value screen will show 10 slpm, not 15 slpm.

Change Units Screen

If you are already in the Lower Level Screens, push the right or left arrow until you reach the Change Units screen. To get to this screen at any time, Press Escape—Press Enter—type password and Press Enter. Then, press the Right or Left arrow until you reach the Change Units Screen.

The display will show:

Change Units
sl/m

If you wish to change the engineering units, press the enter button at this point. The "mass units" will begin to blink. Use the up or down arrows to select an alternate unit. You can choose from the following mass units:

sl
NL
g
kg
lb
scc
Ncc
SCF
NM^3
SM^3

When you are satisfied, push the left or right arrow. You will now see the "time unit" blink. Use the up or down arrows to select your choice of time units. You can choose from the following time units:

m (minutes)
H (hours)
S (seconds)

When you are finished, press the enter button again. You will see:

Change Units
XXX/x

You can make additional changes by using the left and right arrow keys to move to other Lower Level Screens. You may also choose to press the escape key to return to the Upper Level Screens and to observe your change.

NOTE: If a small unit is chosen, the device might not be able to display the valve and might show 9999. You might need to restore factory defaults. See Maintenance Functions starting on page 47.

Change Gas Screen (Dial-A-Gas®)

If you are already in the Lower Level Screens, push the right or left arrow until you reach the Change Gas screen. To get to this screen at any time: Press Escape—Press Enter—type password and Press Enter. Then, press the Right or Left arrow until you reach this screen. The display will show:

<div align="center">

Change Gas
Nitrogen

</div>

If you wish to change the gas used in the instrument, press enter. The name of the gas will blink. Use the up and down arrows to make your selection. When you reach the desired gas, press enter. You will see:

<div align="center">

Change Gas
XXXX

</div>

You can make additional changes by using the left and right arrow keys to move to other Lower Level Screens. You may also choose to press the escape key to return to the Upper Level Screens and to observe your change.

Note: your instrument comes with 10 pre-programmed standard gases. These are listed in the Specifications in Appendix B. SmartTrak may be ordered with alternate gases programmed. If your device was so ordered, you may choose from these 10 gases instead. You may see the 10 gases programmed in your instrument by using this screen and simply scrolling up or down.

Change Valve Operation-Close, Purge

Caution!
The SmartTrak valve is not a positive shut-off device.

If you are already in the Lower Level Screens, push the right or left arrow until you reach the Change Valve Operation screen. To get to this screen at any time: Press Escape—Press Enter—enter password and Press Enter. Then, press the Right or Left arrow until you reach this screen. The display will show:

<div align="center">

Change Valve
Operation

</div>

Automatic

From this screen you may set the valve to open all the way ("Purge"), force the valve to remain closed until further changes are made ("Valve Closed") or set the valve to control flow when it receives a setpoint from some source ("Automatic"). To make a change to the valve operation, press the enter key. Use the up and down arrows to make your selection. When you are satisfied, press the enter key again. You will see:

<div align="center">

Change Valve
Operation
XXXXX

</div>

You can make additional changes by using the left and right arrow keys to move to other Lower Level Screens. You may also choose to press the escape key to return to the Upper Level Screens.

NOTE: The valve will move to the desired position immediately when you press the enter key.

IMPORTANT SAFETY NOTES ABOUT PURGING

WARNING: When toxic or corrosive gases are used, purge unit thoroughly with inert dry gas before disconnecting from the gas line to prevent personnel from being injured when coming in contact with the instrument. Chapter 3 discusses how to purge your instrument. Always neutralize any toxic gas trapped inside the instrument before removing it from the gas line.

WARNING: The flow rate in Purge is much greater than the calibrated full scale value and as a result can be dangerous.

Change Setpoint Source Screen (mass flow controllers only)

If you are already in the Lower Level Screens, push the right or left arrow until you reach the Change Setpoint Source screen. To get to this screen at any time: Press Escape—Press Enter—enter password and Press Enter. Then, press the Right or Left arrow until you reach this screen. The Change Setpoint Source screen allows you to re-configure the location and type of the setpoint for the SmartTrak controller. If you intend to supply the

setpoint command signal from the Pilot Module or a computer using the RS-232 link, the display must show:

Change Setpoint
Source
Pilot/RS232

If, instead of using the Pilot Module or the RS-232 link, you prefer to supply an analog setpoint signal to the SmartTrak, press the enter button. "Pilot/RS232" will begin to blink. Use the up and down arrows to make your selection from the following choices:

0-5 VDC
0-10 VDC
1-5 VDC
0/4-20 mA
Pilot/RS232

When you are satisfied, press enter. You will see:

Change Setpoint
Source
X-XX XX

You can make additional changes by using the left and right arrow keys to move to other Lower Level Screens. You may also choose to press the escape key to return to the Upper Level Screens.

Caution: If you change the source of the setpoint to an analog value, you will not be able to control your SmartTrak mass flow controller via the Pilot Module or the RS-232 link.

Change Output Signals Screen

If you are already in the Lower Level Screens, push the right or left arrow until you reach the Change Output Signals screen. To get to this screen at any time: Press Escape—Press Enter—enter password and Press Enter. Then, press the Right or Left arrow until you reach this screen. The display will show:

**Change Output
Signals
0-5 VDC/0/4-20 mA**

Here you can re-configure the analog output signals for the instrument. The SmartTrak always outputs one current signal of 0/4-20mA but the voltage signal may be selected using this screen. Use the up and down arrows to make your selection. You can choose between:

0-5VDC and 0/4-20mA
0-10VDC and 0/4-20mA
1-5VDC and 0/4-20mA

When you are finished making your selection, press enter. The screen will read:

**Change Output
Signals
X-XX XX/X-XX XX**

You can make additional changes by using the left and right arrow keys to move to other Lower Level Screens. You may also choose to press the escape key to return to the Upper Level Screens.

Change Full Scale Screen

If you are already in the Lower Level Screens, push the right or left arrow until you reach the Change Full Scale screen. To get to this screen at any time: Press Escape—Press Enter—enter password and Press Enter. Then, press the Right or Left arrow until you reach this screen. The display will show:

**Change Full Scale
XX.XX sl/m
Air**

This screen allows you to re-range the outputs of your instrument. You may select any full-scale value between 100% and 50% of the displayed maximum value (this is the factory full-scale calibration value).

The new full-scale value that you select will re-define the analog outputs of the instrument. The 20 mA signal and the corresponding voltage signal (5 VDC, 1-5 VDC or 10 VDC) will now represent this new full-scale value.

Caution: Changing the full-scale value of the instrument does not affect the accuracy.

The accuracy is always ±1% of full scale under calibration conditions of the original factory full-scale calibration value.

Caution: For any instrument, if a value greater than the factory full scale calibration value is entered on this screen, the SmartTrak will modify the requested value to equal the factory full scale calibration value.

If you choose to change the full-scale value, press the enter key. The first digit will blink. Use the up and down arrows to adjust the value of the digit or the left and right arrows to choose another digit. When you have completed your modification, press the enter key. The display will show:

<div align="center">

Change Full Scale
XX.XX sl/m
Air

</div>

You can make additional changes by using the left and right arrow keys to move to other Lower Level Screens. You may also choose to press the escape key to return to the Upper Level Screens.

Change Span Screen

If you are already in the Lower Level Screens, push the right or left arrow until you reach the Change Span screen. To get this screen at any time: Press Escape—Press Enter—enter password and Press Enter. Then, press the Right or Left arrow until you reach this screen.

From this screen you can change the instrument's span distance by a percentage factor ratio. For example, if your meter is reading 1% high of reading, change span to 0.990 (99.0%) and the full scale value should be reduced by 1%. If your controller is controlling 1% below of reading, the same change will bring it in. If the meter is reading 1% low (controller controls 1% high), then change span to 1.010 (101.0%). The display will show:

<div align="center">

Change Span
1.000
Air

</div>

To make a change, press the enter key. The first digit will begin to blink. Use the up and down arrows to modify this digit or the left and right arrows to choose another digit. When you are satisfied, press enter. The display will show:

<div align="center">

Change Span
X.XXX
Air

</div>

Keep in mind that you can change the span for each individual gas, thus, a change in the span to one gas will not affect the span of another gas. You can make additional changes by using the left and right arrow keys to move to other Lower Level Screens. You may also choose to press the escape key to return to the Upper Level Screens.

Zero Meter Screen
If you are already in the Lower Level Screens, push the right or left arrow until you reach the Zero Meter screen. To get this screen at any time: Press Escape—Press Enter—enter password and Press Enter. Then, press the Right or Left arrow until you reach this screen.

From this screen you can change the zero flow bridge differential value to match the zero flow conditions of your application. Mount (or place) the instrument where it is intended to be used, minding orientation, tilt, etc.; The accuracy of this function is dictated on how close to operating conditions the unit is when the meter is zeroed. The display will show:

Zero Meter
Confirm zero flow
Then press enter

Once you push enter, the unit will monitor the sensor bridge differential value. The display will show:
Zero Meter
Confirm zero flow
New Zero

Upon pressing the enter key again, the unit will record the bridge differential value to the zero flow condition, leaving you with a freshly "zeroed" instrument! You can make additional changes by using the left and right arrow keys to move to other Lower Level Screens. You may also choose to press the escape key to return to the Upper Level Screens.

Change Password Screen
If you are already in the Lower Level Screens, push the right or left arrow until you reach the Change Password screen. To get to this screen at any time: Press Escape—Press Enter—enter password and Press Enter. Then, press the Right or Left arrow until you reach this screen.

From this screen you can change the instrument password from the factory default to any four-digit password of your choice. The display will show the factory default password of four zero's: "0000". The display will show:

Change Password
0000

To make a change, press the enter key. The first digit will begin to blink. Use the up and down arrows to modify this digit or the left and right arrows to choose another digit. When you are satisfied, press enter. The display will show:

Change Password
0000

You can make additional changes by using the left and right arrow keys to move to other Lower Level Screens. You may also choose to press the escape key to return to the Upper Level Screens.

Caution: Once you change the Password, you will not be able to enter the Lower Level without it. Be certain the new password is recorded.

Lost Passwords and General Customer Service

The "creator" password is 6363- this will override all other passwords. If this does not work, it will be necessary to contact one of Sierra's Technical Support Centers.

Email Customer Service: service@sierrainstruments.com

FACTORY USA Customer Service:
    TOLL FREE: 800-866-0200
    PHONE: 831-373-0200
    FAX: 831-373-4402
    EMAIL: service@sierrainstruments.com

European Customer Service:
    PHONE: +31 72 5071400
    FAX: +31 72 5071401
    EMAIL: service@sierra-instruments.nl

Asia Customer Service:
    PHONE: + 8221 5879 8521
    FAX: +8621 5879 8586
    EMAIL: www.sierra-asia.com

CHAPTER 5: Digital Operation RS-232 & SmartTrak Software

Your SmartTrak instrument may be operated in three different ways:

THREE CONTROL OPTIONS

A. Analog Input/Output Operation (Chapter 3): Using analog input/output signals at the 15-pin mini- D connector.

B. Digital Operation with Pilot Module (Chapter 4): Using the optional Pilot Module.

C. Digital Operation with RS-232 and SmartTrak Software (This Chapter): Using the RS-232 SmartTrak Software package and a PC-style computer running the Windows operating system.

This chapter will discuss "C" above—Digital Operation with your computer via RS-232 and SmartTrak Software. Although you have chosen to use the RS-232 option, please note that all the Analog control functions are still available on your instrument. Consult Chapter 3 for details on Analog operation. Also, the Pilot Module may be used so long as you make RS-232 communication with the supplied CRN cable. See Chapter 4 for details on operation using the Pilot Module.

If you prefer to write your own software to communicate with the SmartTrak over the RS-232 link, this is certainly possible. Sierra Instruments will provide the Source Code including the Command Set upon request. Unfortunately, this is the limit of software Technical Support we can extend.

Summary of the SmartTrak Features

Your SmartTrak instrument may be easily monitored and adjusted using the supplied SmartTrak Software package. You should note that the SmartTrak Software was designed with all the same functions as the Pilot Module. The software allows you to see all changes & parameters at a glance and will allow you to make changes quickly and easily. For review, the features of the SmartTrak include:

1. Top Level Screens that display information In our software, these screens appear as yellow boxes. They include:

   ❖ Mass flow rate
   ❖ Gas (10 options pre-programmed, one must be AIR)
   ❖ Engineering units (mass per unit time)
   ❖ Current Setpoint with units
   ❖ Source of Setpoint (analog or digital and type)

❖ Valve operation mode (normal, valve shut or purge)
❖ Current meter full scale value with units (user selectable)

2. Lower level Screens that permit changes to instrument operation In our software, these screens appear as white boxes. They include:
❖ Setpoint value
❖ Engineering units
❖ Gas
❖ Valve operation
❖ Source of the setpoint signal
❖ Form of the output signals
❖ Full scale of the instrument
❖ Zero meter
❖ Span meter

3. Additional Features include:
❖ Re-boot the SmartTrak microprocessor
❖ Change the Communication Port
❖ Links to Sierra Instruments' Web Site
❖ Specifications

Power Up Your Instrument

CAUTION: The SmartTrak is not a loop-powered device. Do not apply power to the 0/4-20mA outputs.

After your instrument is installed and the system has undergone a complete leak check (discussed in detail in Chapter 2), apply power using Sierra's power supply or your own input power source. See Chapter 2, for power supply requirements. The green LED at the top of the left side will light. If your instrument has a Pilot Module, it will begin its start-up cycle. See Chapter 4 for details on Pilot Module operation.

If you have a Mass Flow Controller, the valve will remain closed until power is supplied. Remember that the valve in the SmartTrak controller is not a positive shut-off device. When power is applied, the flow control valve will operate per any instructions it receives. When the SmartTrak is delivered, the valve will be in the Automatic (Normal) state and the Pilot Module will provide the correct zero setpoint reference for the instrument. As a result, the valve will be closed. However, the valve will return to the state it was in the last time the instrument was operated.

CAUTION: If you do not know the position of the valve before it was shut down, you must assume that the valve will open when power is applied. Take necessary precautions.

Power Up Your Computer

Apply power to your computer per the manufacturer's recommendations. The SmartTrak Software is compatible with any computer running a windows operating system of 2000 or above.

Loading the SmartTrak Software

1. Download at

    https://www.sierrainstruments.com/products/downloads/smarttrak-100-mass-flow-meters-controllers

CAUTION: It is recommended that you do not change the default installation directory for this software. The default directory is:
<div align="center">

C-drive:\ Program Files.
</div>

Changing the installation directory may lead to malfunctions in the software.

Connecting SmartTrak to Your Computer

If your computer has a serial port…

We suggest you use the optional Sierra Instruments RS-232 communication cable (part number CRN). This pre-manufactured cable has the correct DB9 connection to mate with most computers and a CAT 5 connector which should be connected to the jack on the side of your new instrument.

With your SmartTrak **POWERED,** plug CAT 5 connector into the receptacle on the side of your SmartTrak instrument (See Figure 5-1: SmartTrak Connections). Next, plug the DB-9 connector to an appropriate serial port on your computer. Note the serial port channel number, especially if there is more than one serial port available.   If your

computer has only one serial port, it is often named "Comm Port 1." You will need to know the Comm Port number to communicate with your SmartTrak instrument.

CAUTION: The CAT-5 connector on the side of the SmartTrak is NOT an Ethernet connector. Do not plug an Ethernet cable here as damage may result.

All electrical connections for your SmartTrak instrument are made on the left (inlet) side panel.
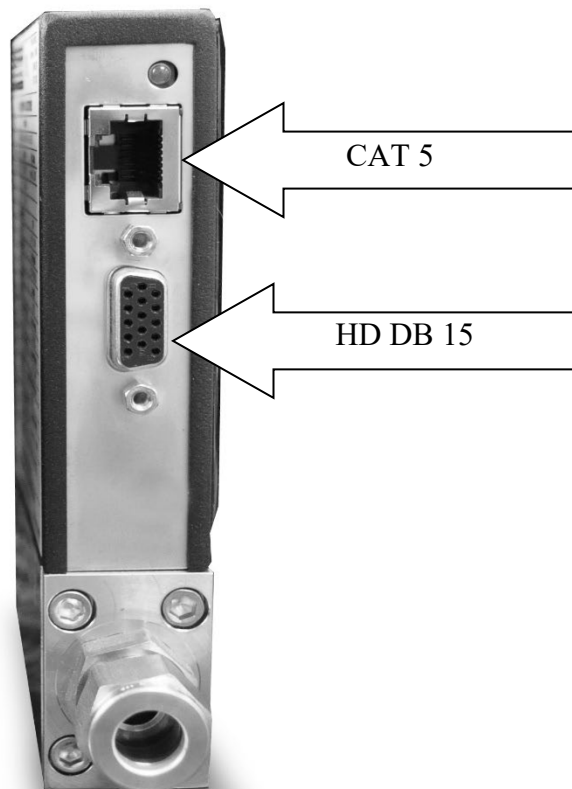
Figure 5-1: SmartTrak Connections

If you do not have the Pilot Module display, you can connect pins 7 (serial transmit), 13 (serial receive) and 3 (analog ground) on the instrument's 15-pin mini- D Connector to an appropriate serial port using a standard DB-9 connector instead of using the supplied CRN cable (see Chapter 2 for wiring instructions). If you use the mini-D connector for your RS-232 communication, please shield the cable to prevent EMI from disrupting communications.

If your computer has no serial port, but has a USB port…

Perform the identical connections as if your computer has a serial port (see previous paragraph), but do not plug the DB-9 connector into your computer. Instead, purchase an appropriate Serial to USB converter. Plug the DB-9 connector into your Serial to USB converter and then plug the USB connector into your computer. Load the necessary software driver into your computer to operate the converter (software and instructions should come with the converter).

Your computer will assign a Comm Port number to your USB adapter, but it will probably not be "Comm Port 1." Use the Control Panel feature of your computer to identify which Comm Port number has been assigned to your USB adapter.

Open "My Computer" from your desktop.
Next, open "Control Panel."
Then, open "System."
Click on the tab labeled "Device Manager."
Scan down the list until you see the word "Ports," then right double-click to examine the available Com Ports. Record the number(s). You will need to enter this number or one of these numbers to communicate with your SmartTrak instrument.

If you plan to control more than one SmartTrak instrument from your computer…

If your computer has a number of serial ports equal to the number of instruments you wish to operate, simply plug each instrument into a separate serial port as directed above in "If your Computer has a Serial Port…"

If you wish to operate more instruments than your computer has serial ports, you will usually have to use USB ports instead. If the number of USB ports in your computer equals the number of instruments, then purchase one serial to USB converter per SmartTrak and follow the instructions above. If you have more instruments than ports, you will need to acquire an edge port device (converts one USB port into several serial ports) or a USB hub (converts one USB port into many USB ports). Once you have attached the necessary device and loaded the proper drivers, connect your SmartTrak

instruments to the serial or USB ports as outlined in the sections above. Open a separate software window for each meter and you can monitor all of them at one time.

If connecting your computer to the SmartTrak creates any confusion, please contact Sierra Instruments or your IT person for assistance.

Running the SmartTrak Software

Locate the file named "SmartTrak" and open it. You will see the following screen: This is the main data screen. First, you must select the proper comport.
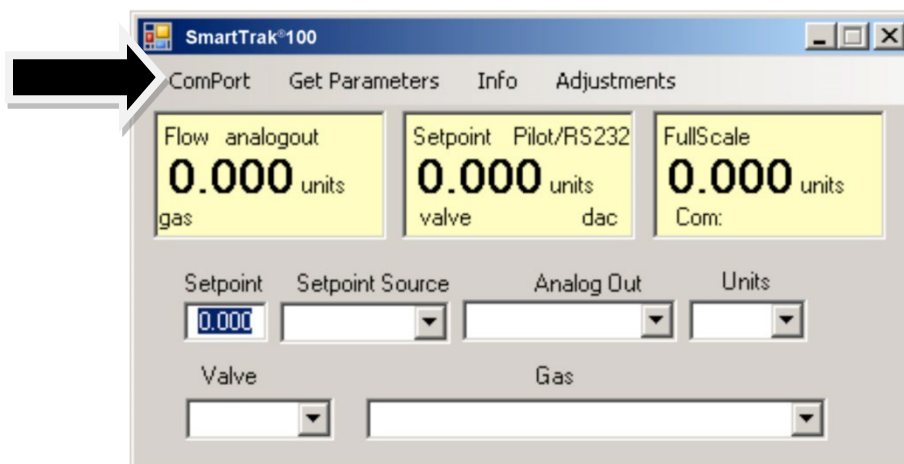
Select the comport pull down menu:
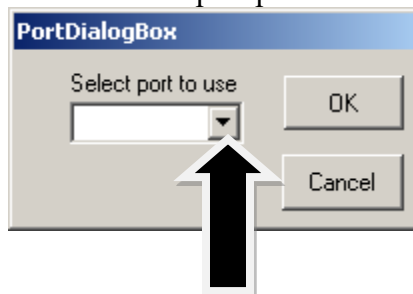
Use the pull-down menu to choose the port number that corresponds to the serial port channel your SmartTrak is connected to (from 1 to 255). If you have only one serial port, select "Comm Port 1." When finished, click on the box marked "OK."

You will be returned to the the SmartTrak Master Screen. The screen is the same for both meters and controllers. Controller functions will not be active for meters and vice versa

Establishing Communication

If the Screen appears with all the yellow and white boxes full, the SmartTrak instrument has established communication with your computer.
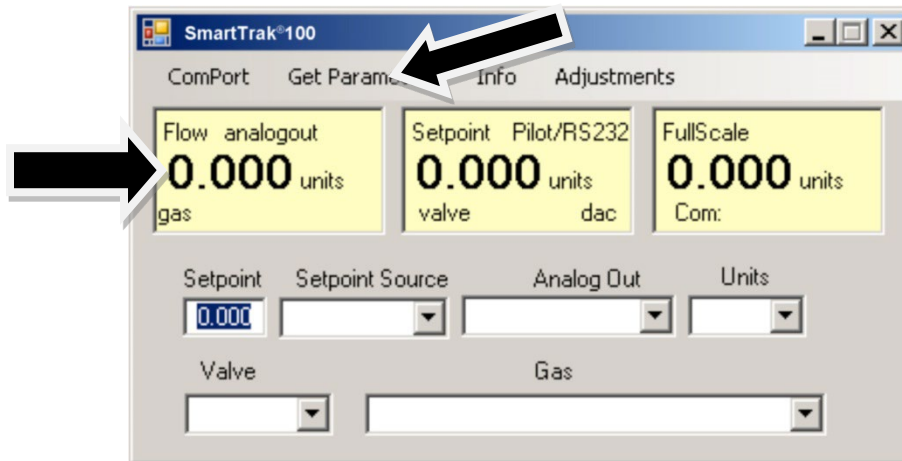

Proceed to the next section.

If the screen appears, but the yellow and white boxes are all empty, you have selected the wrong "Com Port number." See the section titled "Com Port" on page 5-16 for instructions on how to change the communication port number.

If the screen appears, but only the Mass Flow box shows a value, you are using the correct Com Port, but your computer is not talking to the SmartTrak. To begin communication, move the mouse pointer to the top center screen and left click on the words "Get Parameters." then values will fill all the boxes on the screen. Communication has been established. Your computer is now able to control your SmartTrak instrument.

Your SmartTrak instrument is now ready for use!

Using the SmartTrak Software

A. Upper Section of Software Window

Across the upper half of the SmartTrak Software window you will see 3 yellow boxes. These are titled:

❖ Flow
❖ Setpoint (flow controllers only. Will show zero for meters)
❖ Full Scale
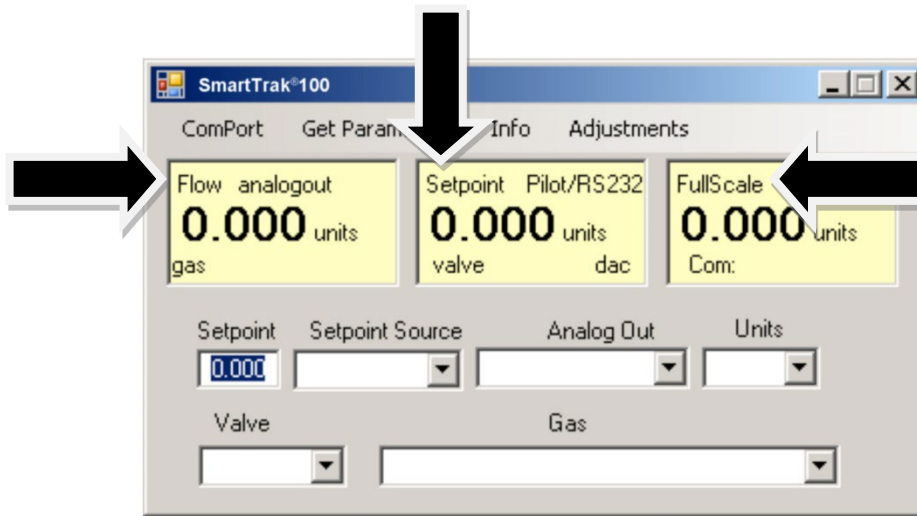
These boxes display the current operating conditions of your SmartTrak instrument. If you have the Pilot Module, these boxes on the upper half of the software screen are identical to the Upper Level Screens on the Pilot Module discussed in Chapter 4. The features of these boxes are described below.

Flow

The box displays the mass flow rate, the engineering units, the gas choice and the analog output choice.
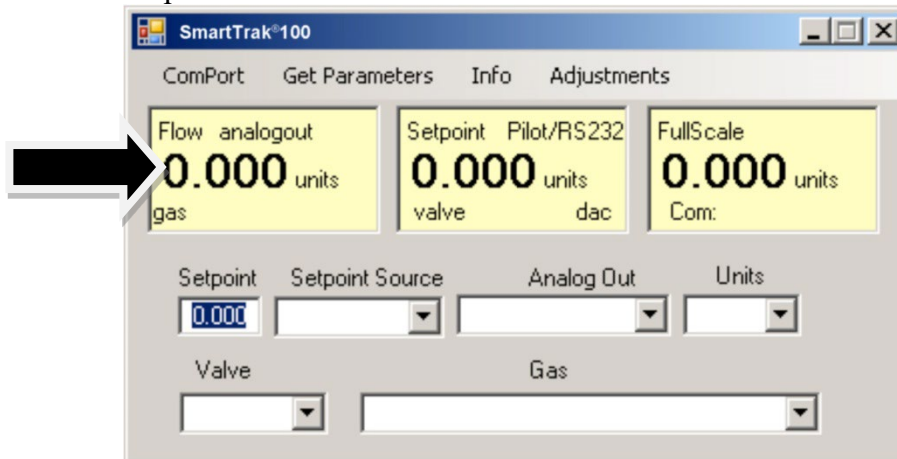
Setpoint

If you have a Mass Flow Meter, this box is zero (as shown above). The Setpoint box displays the current setpoint given to the flow controller, the engineering units, the source of the setpoint signal, the current valve state (open, closed or purge) and the dac values for the valve (for Sierra troubleshooting only).
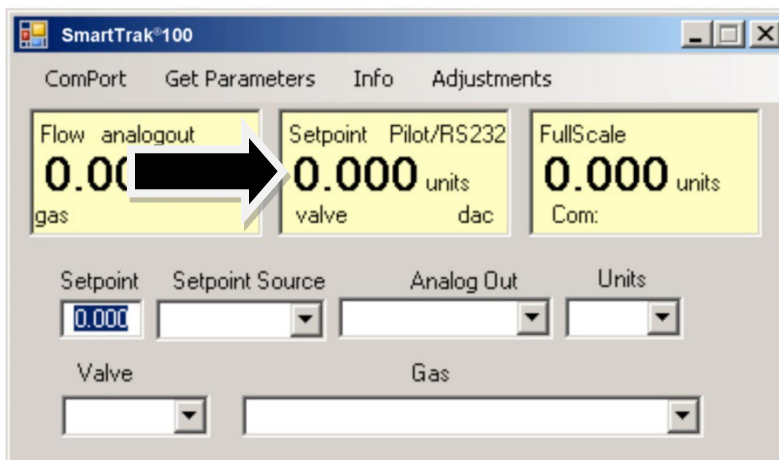
CAUTION: If this box does not show Pilot Module/RS-232 on the first line, you will not be able to give the controller a setpoint command from your computer. This is because you SmartTrak is expecting an analog setpoint at the 15-pin mini- D-connector. To supply a setpoint from your computer, see "Change Setpoint Source" on page 5-13.

Note on Valve

If you have a Mass Flow Meter, this information can be bypassed. For normal operation of the flow controller, this line should display Automatic. If this is visible, the instrument will automatically control flow as soon as a setpoint is given to it.
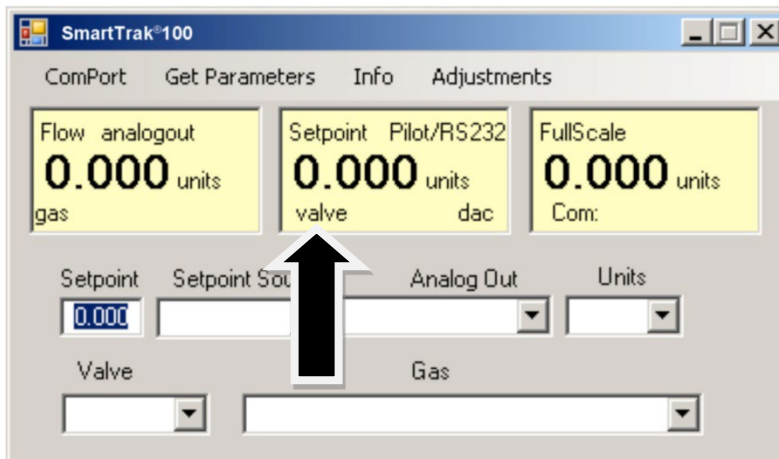
If this box does not display "Automatic," it will not be possible to control gas flow. Your valve is locked open (Purge) or closed (Closed). See the section titled "Change Valve Operation" below for further instructions

Full Scale

This screen displays the current full-scale value of the instrument with engineering units. It also displays the com port selected and a counter for the com port (for Sierra Troubleshooting only).
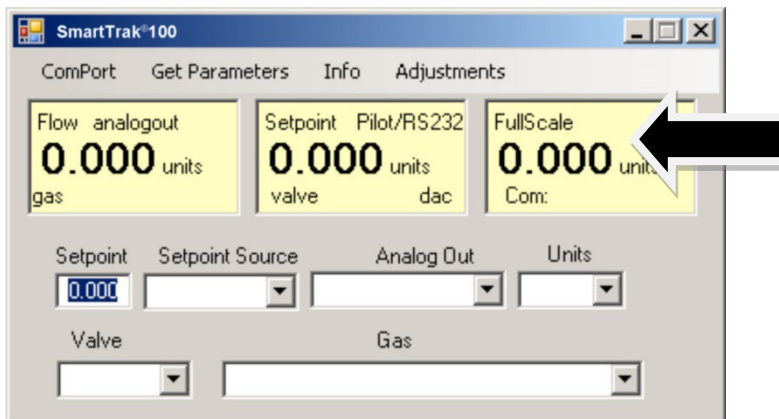
B. Lower Section of Software Window– Changing Parameters

Across the bottom half of the screen you will find a number of white boxes. Each box allows you to adjust one or more meter functions. The various functions are reviewed in the following section.
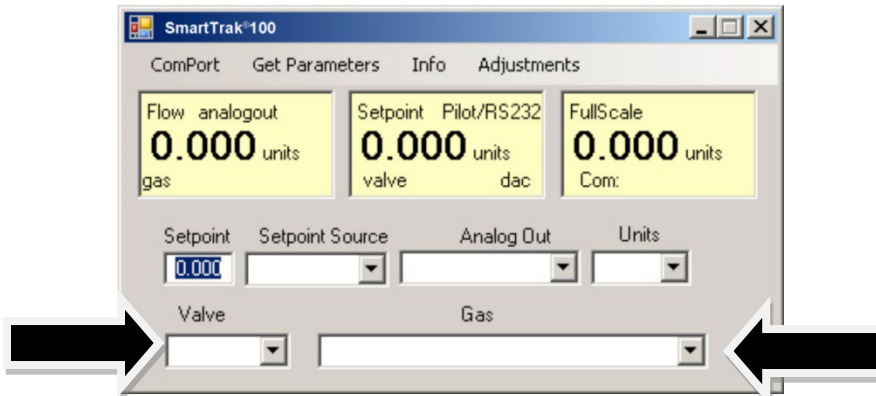
Change Setpoint Value (flow controllers only)

This is the box that allows you to change the setpoint of the mass flow controller. To make a change to the setpoint value, move your pointer to this box and left click. You may change a digit or delete the current setpoint and key in a new one. When you have made your selection, press the enter key to implement it.
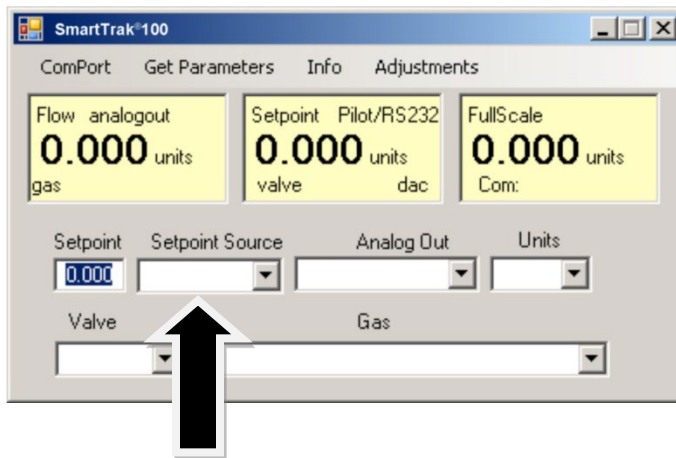
If, instead of using the RS-232 link or the Pilot Module, you prefer to supply analog set point signal to the SmartTrak, activate the pull-down menu. Make your selection carefully and click. Your selection will appear in the box and, after a few seconds, it will also appear in the yellow setpoint box.

CAUTION: If you change the source of the setpoint to one of the analog values, you will not be able to control your SmartTrak with your computer.

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Change Valve Operation –Automatic, Close, Purge

This function enables or overrides any setpoint command given to the SmartTrak. At start-up, the box will show **Automatic:**
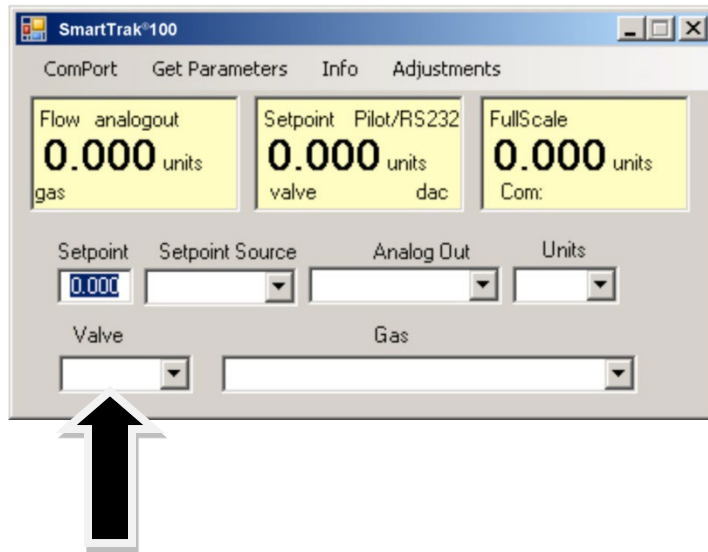
In this normal operating position, the valve is ready to control flow when it receives a setpoint from some source. Using this box, you may set the valve to open well beyond its normal maximum position ("Purge") or force the valve to remain shut regardless of setpoint ("Closed"). Use the pull down menu to make this change. Choose "purge" to fully open the valve regardless of the given setpoint or choose "closed" to override any setpoint command and close the valve.

CAUTION: Do not activate the valve state pull-down menus unless you are ready to make this change. Once in the pull-down menu, if you click on one of the selections, the valve operation will change immediately. Remember that the SmartTrak is not a positive shut-off device.

Change Gas (Dial-A-Gas®)

This box will display the current gas selection. If you wish to change the gas used in the instrument, activate the pull-down menu. The 10 gases programmed into the memory of your SmartTrak will be displayed.
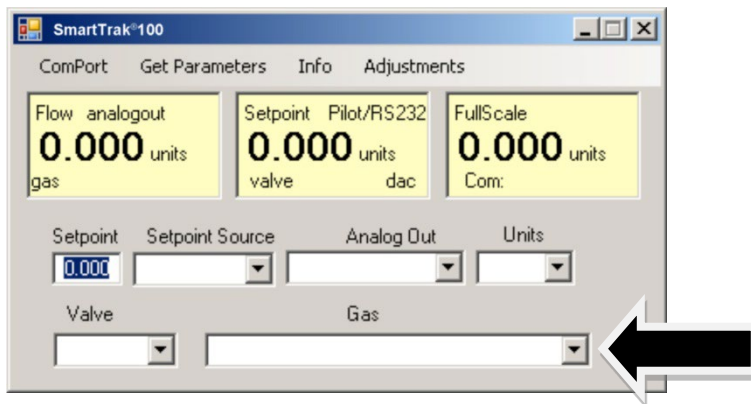
Choose the correct gas for your current application and click. The new gas selection will appear in the box. Within a few seconds, the new gas selection will also appear in the yellow Flow box and the values of the mass flow, setpoint and the full scale will be adjusted for this new gas. This is normal. In some cases, where the thermal properties of one gas are very similar to another, these values may not change very much.

Change Units

This box will show the current engineering units. Should you wish to change the engineering units, use the pull-down menu.
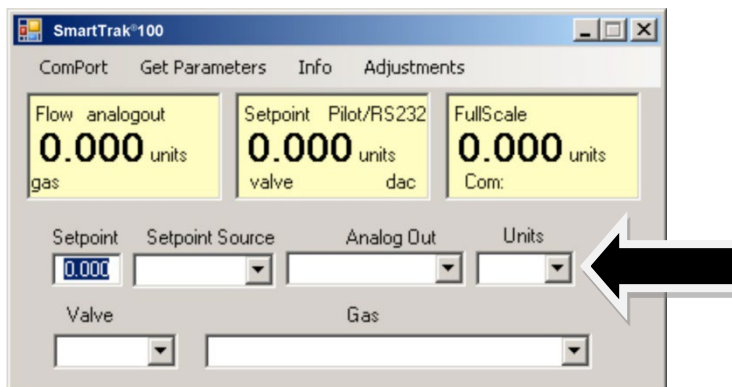
Make your selection, noting that each engineering unit is available with 3 different time constants: seconds, minutes and hours. Choose the combination of units and time constants you desire, then click. The box will display your new selection. Within a few seconds, the units will change in the Flow, Setpoint, and Full Scale boxes and the numerical values will be adjusted into the new units.

Change Analog Out

This box will show the two analog output signals currently selected for your instrument. To re-configure the analog output signals, use the pull-down and make your selection. The SmartTrak will adjust the analog output voltage signal per your instruction.
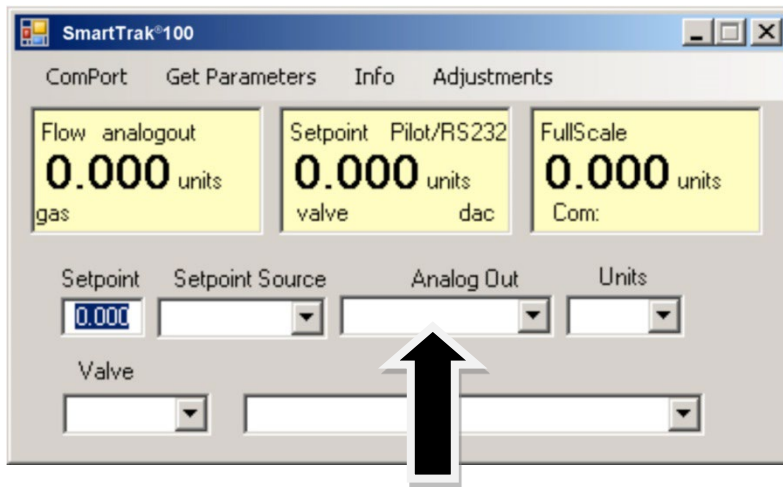
C: ADJUSTMENTS:

Clicking on "adjustments" brings up the meter settings screen.
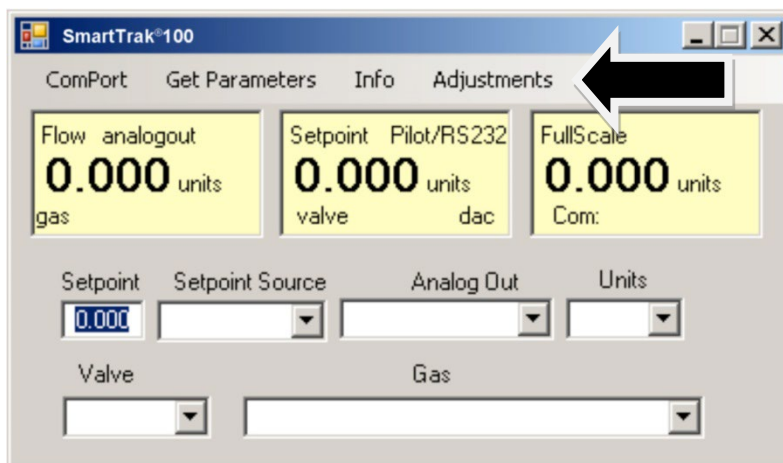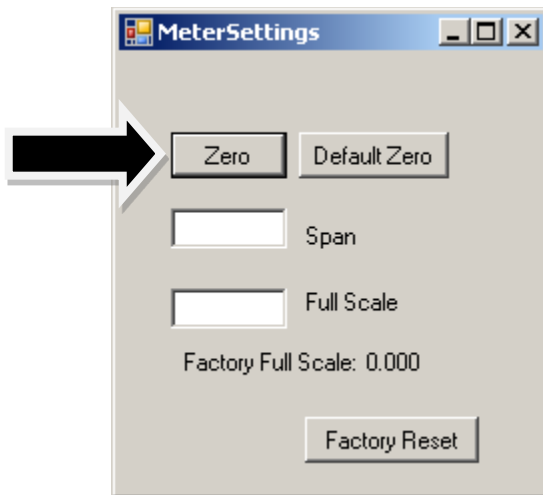
This screen allows for zeroing, spanning and adjusting the full scale for each of the 10 gases in the gas table individually. The screen will be displayed for the gas selected in the gas table on the main screen

Caution: the values in this screen can be set individually for each of the 10 gases. MODIFICATIONS of this screen will only be applicable to the gas displayed. To modify other gases, change the gas in the pull down menu and repeat.

Change Zero:
This button automatically zeros the meter.
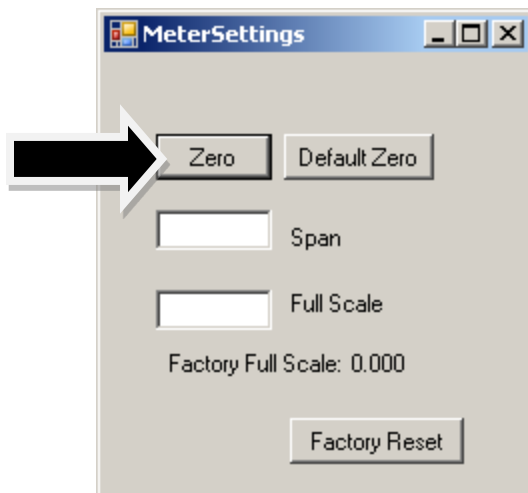
To perform this zero procedure, you must make sure that the actual flow is zero. Attempting to zero the meter or controller while there is a flow condition will cause an

offset. Also, the best zero is obtained by using the actual gas at the listed operating pressure.

After 30 minutes, if your zero reading and/or calibration are off (i.e. show flow at zero), we recommend that you perform the re-zeroing procedure. Refer to page 45 "Zero Meter Screen" for instructions.

Default zero:

This will set the zero value back to factory conditions. Use this in order to recover from a mistaken entry.
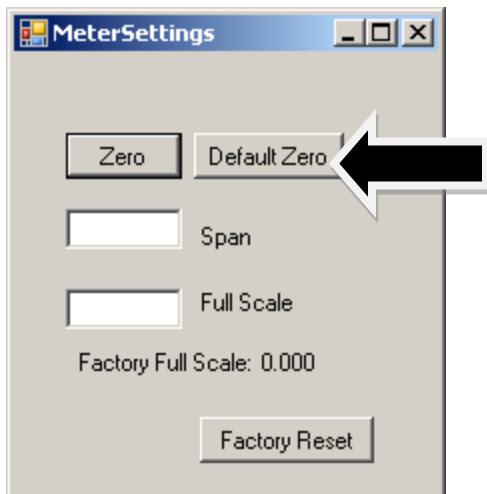
Span:

This allows the user to enter an offset to the span to adjust the meter outputs to match another device or field conditions. The span is a MULITPLIER and will multiply all outputs by the entered amount.
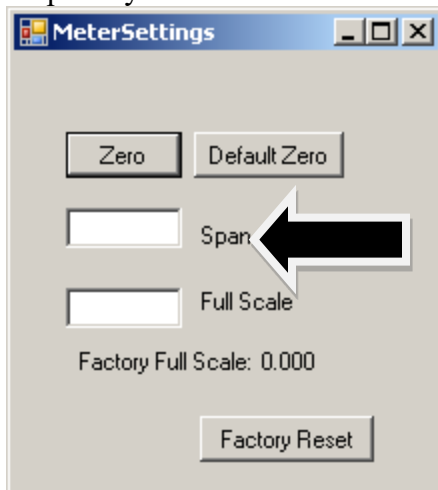
For example, the meter reads 98. The desired reading is 100. A span value of 1.02 will adjust the meter output to read 100.

Caution: this number should not be adjusted beyond 0.8 to 1.2.

Change full scale:

This setting allows you to change the full scale of your instrument
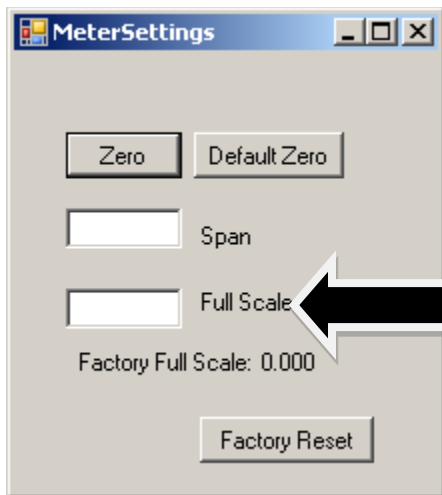
The instrument will display its current full-scale value. If your instrument is new or this value has never been modified, the value displayed will be 100% of the maximum flow rate your SmartTrak can measure or control without factory re-calibration. This is the number listed here:
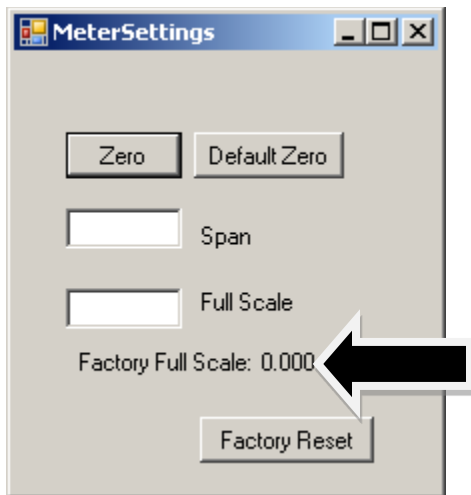
 The instrument's maximum flow rate is also recorded on the data label (at the back of the instrument) and on the calibration certificate.

You may select any full-scale value between 100% and 50% of the maximum full-scale value.   If you select a new full-scale value, it will re-define the analog outputs of the instrument. The 20 mA signal and the corresponding voltage signal (5 or 10 VDC) will now represent this new full-scale value.

To change the full-scale value of your device, modify one digit or erase the current value displayed and type in your desired full-scale value. When you are satisfied with your selection, press the enter key. The new full-scale value will appear in the white box. A few seconds later, the same value will appear in the yellow box in the upper half of the screen titled "Full Scale."

CAUTION: The Change Full Scale function allows you to re-range your instrument, but it is important to be aware of the limitations of this function.
Changing beyond recommended values may require a new LFE or even flow body be installed. If in doubt, select factory reset and both zero and span values are reset to factory values
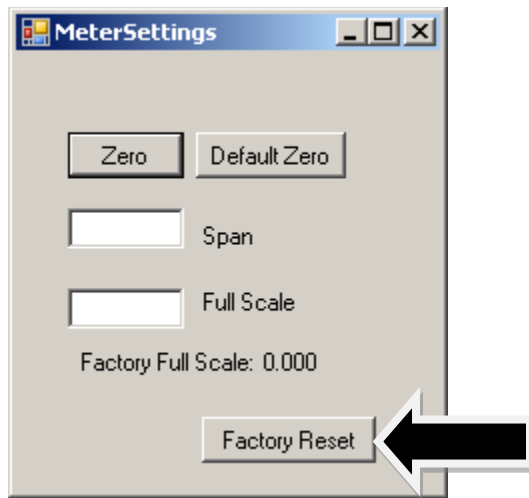
Here are some guidelines to remember if you choose to modify the Full Scale Value:
Changing the full-scale value of the instrument does not affect the accuracy of the
measurement. Instrument accuracy is a percentage of the original factory full-scale value

If you enter a full-scale value beyond the instrument's calibrated maximum range, the
SmartTrak will automatically modify the full-scale to equal the factory full-scale value.
Below 1% of the original factory full-scale value for a meter and 2% for a controller, your
SmartTrak is programmed to read zero because the error in the measurement may exceed
the measurement itself.

Other Useful Features

There are several additional features that you may utilize via the SmartTrak Software.
Across the top of the SmartTrak Master Screen, you can see these options:

Com Port
Read Parameters
Info

To use any of these functions, simply place the mouse pointer onto the name of the feature
you wish and left click.

Com Port
To change the communication port for the SmartTrak, click on this feature. Use the pull
down menu to choose the Comm Port that your SmartTrak's serial connector is plugged
into. Remember that the software asks you to confirm your Comm Port every time you re-
start. This feature is designed for situations when you have multiple Comm Ports available
and you wish to move the SmartTrak from one to another or you are controlling more than
one SmartTrak at one time.

Read Controller Parameters

Use this function if you believe your computer and your SmartTrak instrument may have stopped communicating. It is essentially a re-boot command for the SmartTrak microprocessor. When you switch Comm Ports, it is recommended that you use this function. If your computer requires a re-boot and you do not unplug your SmartTrak, the communication link will be broken. Use this function to re-establish communication. If at any time, the instrument does not appear to be sending correct information to the SmartTrak software, try this command to ensure communication.

Info

This gives information about the meter serial and software revisions.

CHAPTER 6: TECHNICAL SUPPORT & SERVICE

Technical Support

If you encounter any problem with your instrument, review the configuration information for each step of the installation, operation, and set up procedures as explained in this manual. Verify that your settings and adjustments are consistent with factory recommendations.

If the problem persists, Sierra is eager to help you. You may contact us at any of the following Technical Support Centers. It may also help to call your Sierra Sales Agent, who is also well trained in the operation of the product.

IMPORTANT: When contacting Technical Support, make sure you have included the following information*:*

- The flow range, serial number, Sierra order number and model number (all marked on the instrument data label).
- The problem you are encountering and any corrective action taken.
- Application information (gas, pressure, temperature, pipe and fitting configuration).

<u>CUSTOMER SERVICE AND SUPPORT INFORMATION</u>:

Email Technical Support: service@sierrainstruments.com
Email Sales: sales@sierrainstruments.com

FACTORY USA
TOLL FREE: 800-866-0200
PHONE: 831-373-0200
FAX: 831-373-4402
EMAIL: service@sierrainstruments.com

European Sales & Service Center:
PHONE: +31 72 5071400
FAX: +31 72 5071401
EMAIL: service@sierra-instruments.nl

Asia Sales & Service Center:
PHONE: + 8221 5879 8521
FAX: +8621 5879 8586
EMAIL: www.sierra-asia.com

Sierra Website

www.sierrainstruments.com

Returning Equipment to the Factory

Factory Calibration—All Models

Sierra Instruments maintains a fully-equipped calibration laboratory. All measuring and test equipment used in the calibration of Sierra transducers are traceable to NIST Standards. Sierra is ISO-9001 registered and conforms (but is not certified) to the requirements of ISO 17025.

Instructions for Returning Your Instrument for Service

The following information will help you return your instrument to Sierra Instruments' Factory Service Center and will ensure that your order is processed promptly. Prices may vary depending on the flow range, type of gas and operating pressure of your unit. To request a rough estimate of the pricing, contact your local Sierra Instruments distributor or contact one of our offices directly. A detailed quote will be provided following a full evaluation of your instrument.

Please follow these easy steps to return your instrument for factory service:

Obtain a Return Materials Authorization (RMA) number from the Sierra Instruments website at http://www.sierrainstruments.com/rma/login.php

If you require service beyond calibration, but do not know which service(s) will be required, describe the symptoms as accurately as possible on the RMA form.

Pack your instrument carefully. Use the original packaging and foam or bubble wrap (packing peanuts NOT recommended) and include a copy of the RMA form (complete with Sierra supplied RMA number) with the unit(s).

Ship the unit(s) to the following address:

Sierra Instruments, Inc.
Attention: Factory Service Center
5 Harris Court, Building L
Monterey, CA 93940 USA
RE: RMA# (your number)

IMPORTANT SAFETY NOTE ABOUT PURGING

WARNING: When toxic or corrosive gases are used, purge unit thoroughly with inert dry gas before disconnecting from the gas line to prevent personnel from being injured when coming in contact with the instrument.

WARNING: If an instrument used with a toxic or corrosive gas is returned to the factory, a Material Safety Data Sheet (MSDS) must be enclosed & attached to the outside of the box to alert Sierra personnel of the potential hazard. Also, make sure the inlet & outlet are solidly plugged off.

Appendix A: C100/M100 SmartTrak Product Specifications, Dimensions and Mounting

2 **PERFORMANCE SPECIFICATIONS**

Accuracy
Standard: ± 1.0 % of full scale including linearity under calibration conditions

Dial-A-Gas
± 1.0 % of full scale in all 10 standard gases (see chart below)

Repeatability
± 0.2% of full scale

Temperature Coefficient
± 0.025% of full scale per °F (± 0.05% of full scale per °C), or better

Pressure Coefficient
± 0.01% of full scale per psi (± 0.15% of full scale per bar), or better

Response Time
2 seconds (typical) to within ± 2% of final value (includes settling time), faster or slower available upon request (controllers only).

OPERATION SPECIFICATIONS

Mass Flow Rates
M100L Low Flow: 0-10 sccm to 0-50 slpm
M100M Medium Flow: 0-20 slpm up to 0-200 slpm
M100H High flow: 0-100 to 0-500 slpm full scale
M100H1 High flow: 0-501 to 0-800 slpm full scale
M100H2 High: 0-801 to 0-1000 slpm full scale
C100L Low Flow: 0-10 sccm to 0-50 slpm
C100M Medium Flow: 0-20 slpm up to 0-200 slpm
C100H High flow: 0-100 to 0-500 slpm
C100H1 High flow: 0-501 to 0-800 slpm full scale
C100H2 High flow: 0-801 to 0-1000 slpm full scale

Flow ranges specified are for an equivalent flow of nitrogen at 760 mm Hg and 21°C (70°F); other ranges in other units are available (e.g., nlpm, scfh, nm3/h, kg/h)

Gases
Measures and controls all clean gases including certain corrosives and toxics; specify when ordering.

The following ten gases make up the Dial-A-Gas® feature of every SmartTrak instrument; up to nine alternate gases may be substituted.

Dial -A-Gas Flow Rates			
Gas	Max Flow rate (slpm) Low Flow Size	Max Flow rate (slpm) Medium Flow Size	Max Flow rate (slpm) High Flow Size
Air	50	200	1000
Argon (Ar)	69.9	279.6	1398
Carbon Dioxide (CO$_2$)	36.8	147.4	737
Carbon Monoxide (CO)	50.1	200.4	1002
Methane (CH$_4$)	37.7	150.8	754
Helium (He)	69.9	279.8	1399
Hydrogen (H$_2$)	50	200.2	1001
Oxygen (O$_2$)	49.9	199.4	998
Nitrogen (N$_2$)	50.1	200.4	1002
Nitrous Oxide (N20)	35.8	143.2	716

Gas and Ambient Temperature
32 to 122°F (0 to 50°C)

Standard Gas Pressure
500 psig (34.5 barg) maximum, burst tested to 750 psig (51.7 barg)

Leak Integrity
5 X 10-9 atm cc/sec of helium or better

Power Requirements
(ripple should not exceed 100 mV peak-to-peak)
For Mass Flow Meters:
24 VDC ±10%, (230 mA, regulated)

For Mass Flow Controllers:
C100L: 24 VDC ±10% (500 mA, regulated)
C100M: 24 VDC ±10%, (800 mA, regulated)
C100H: 24 VDC ±10%, (1260 mA, regulated)

Control Range For Controllers
5–100% of full scale flow; zero-flow cut-off at 1.9%.

Output Signal
Analog:
Linear 4–20 mA, 500 ohms maximum loop resistance and one of the following (user selectable):
Linear 0–5 VDC, 1000 ohms minimum load resistance
Linear 0-10 VDC, 1000 ohms minimum load resistance
Linear 1-5 VDC, 1000 ohms minimum load resistance

Command Signal
Analog signal (Impedance) choice of one:
Linear 4–20 mA (110 Ohm), 0–5 VDC (22K Ohm), 0-10 VDC (15.3K Ohm), 1-5 VDC (22K Ohm)

Wetted Material
316 stainless steel or equivalent; 416 stainless steel;
Viton "O"-rings and valve seat standard;
other elastomers are available (consult factory)

DIGITAL SPECIFICATIONS

RS-232 is standard with all SmartTrak models

RS-485 communication with Modbus RTU protocol allows digital multidrop networks

Available with optional LCD display

Internal gas flow totalizer with adjustable pulse output (available with CMDD, CMNR option only)

One analog input can be configured by user with Modbus or included software for a wide variety of process controls

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® Nylon, Viton, Neoprene, Kalrez are registered trademarks of DuPont,
® Windows is a registered trademark of Microsoft

Pressure Drop Across a Meter   3

Pressure must be above the values in the table below. Note that pressure increases with flow rate.

Minimum Pressure Drop for Air, Mass Flow Meters				
	Pressure Drop in PSI (mbar)			
Flow Rate (slpm)	Low Flow ¼ inch fittings (Standard)	Low Flow ⅜ fittings (Optional)	Medium Flow ⅜ or ½ inch fittings	High Flow Small Bore (100H) (std up to 500 slpm) ½ comp fittings	High Flow Large Bore (H1, H2) (std 501-1000 slpm) ¾ comp fittings
0.1	0.36 (24.5)	N/A	N/A	N/A	N/A
0.5	0.36 (24.5)	N/A	N/A	N/A	N/A
1	0.37 (25.4)	N/A	N/A	N/A	N/A
10	0.46 (31.7)	0.41 (28.6)	N/A	N/A	N/A
20	0.66 (45.7)	0.47 (32.7)	0.5 (34)	N/A	N/A
30	N/A	0.59 (40.9)	0.5 (34)	N/A	N/A
40	N/A	0.77 (53.3)	0.5 (34)	N/A	N/A
50	N/A	1.00 (68)	0.5 (34)	N/A	N/A
100	N/A	N/A	1.0 (68)	1.0 (68)	0.5 (34)
150	N/A	N/A	2.0 (136)	1.2 (81.6)	0.5 (34)
200	N/A	N/A	3.0 (204)	1.5 (102)	0.5 (34)
250	N/A	N/A	N/A	1.8 (122.4)	0.5 (34)
300	N/A	N/A	N/A	2 (204)	0.9 (61.2)
350	N/A	N/A	N/A	2.5 (170)	0.7 (47.6)
400	N/A	N/A	N/A	3 (204)	0.9 (61.2)
450	N/A	N/A	N/A	3.5 (238)	1.1 (74.8)
500	N/A	N/A	N/A	4 (272)	1.3 (88.4)
750	N/A	N/A	N/A	6 (408)*	3.0 (204)
1000	N/A	N/A	N/A	10 (680)*	5.0 (340)

Minimum Differential Pressure Requirement for Air, Mass Flow Controllers				
	Pressure Drop in PSI (mbar)			
Flow Rate (slpm)	Low Flow ¼ inch fittings (Standard)	Low Flow ⅜ fittings (Optional)	Medium Flow ⅜ or ½ inch fittings	High Flow Small Bore (100H) (std up to 500 slpm) ½ comp fittings	High Flow Large Bore (H1, H2) (std 501-1000 slpm) ¾ comp fittings
0.1	1 (68)	1 (68)	N/A	N/A	N/A
1	1.5 (102)	1.28 (87)	N/A	N/A	N/A
10	6 (408)	3.8 (258)	N/A	N/A	N/A
20	12 (816)	6.6 (449)	1 (68)	N/A	N/A
30	15 (1020)	9.4 (639)	1.2 (82)	N/A	N/A
40	30 (2040)	12.2 (830)	1.6 (110)	N/A	N/A
50	40 (2720)	15 (1020)	2 (136)	N/A	N/A
100	N/A	N/A	5 (340)	1.5 (102)	1.0 (68)
150	N/A	N/A	10 (680)	2 (136)	1.0 (68)
200	N/A	N/A	15 (1020)	4.5 (306)	1.0 (68)
250	N/A	N/A	N/A	5.5 (374)	1.5 (102)
300	N/A	N/A	N/A	6.5 (442)	2.0 (136)
350	N/A	N/A	N/A	8.5 (578)	3.0 (204)
400	N/A	N/A	N/A	10.5 (714)	4.0 (408)
450	N/A	N/A	N/A	13 (884)	5.0 (340)
500	N/A	N/A	N/A	15 (1020)	6.0 (408)
750	N/A	N/A	N/A	N/A	15 (1020)
1000	N/A	N/A	N/A	N/A	20 (1360)

PHYSICAL DIMENSIONS

SmartTrak 100

SmartTrak 100
with Compod

Hand-Held Pilot Module

All dimensions are in inches with (mm) in brackets. Certified drawings are available on request.

Dimension L							
	Length with Fittings in Inches (mm)						
Fittings	C100L, M100L	C100M	M100M 100 High Pressure	M100H	M100H1, H2	C100H	C100H1, H2
1/8 compression	4.8 (123)	N/A	N/A	N/A	N/A	N/A	N/A
1/4 compression	5.02 (128)	6.52 (167)	6.02 (154)	N/A	N/A	N/A	N/A
3/8 compression	5.14 (132)	6.64 (170)	6.14 (157)	N/A	N/A	N/A	N/A
1/2 compression	5.3 (135)	6.80 (174)	6.30 (162)	8.29 (229)	N/A	10.37 (266)	N/A
1/4 VCO	4.56 (117)	6.06 (155)	5.56 (143)	N/A	N/A	N/A	N/A
1/2 VCO	5.0 (128)	6.50 (167)	6.00 (154)	8.56 (220)	N/A	10.01 (257)	N/A
3/4 VCO	N/A	N/A	N/A	N/A	8.78 (225)	N/A	11.28
1/4 VCR	4.88 (125)	6.38 (164)	5.88 (151)	N/A	N/A	N/A	N/A
1/2 VCR	5.18 (133)	6.68 (171)	6.18 (158)	8.98 (230)	N/A	10.43 (297)	N/A
6 mm compression	5.04 (129)	6.54 (168)	6.20 (155)	N/A	N/A	N/A	N/A
10 mm compression	5.20 (133)	6.70 (172)	6.38 (164)	N/A	N/A	N/A	N/A
12 mm compression	5.38 (138)	6.88 (176)	6.38 (164)	8.90 (288)	N/A	10.35 (265)	N/A
1/4 FNPT	4.85 (124)	6.35 (163)	5.85 (150)	N/A	N/A	N/A	N/A
3/8 FNPT	5.00 (128)	6.50 (167)	6.00 (154)	N/A	N/A	N/A	N/A
1/2 FNPT	N/A	N/A	N/A	9.14 (234)	N/A	10.59 (272)	N/A
3/4 FNPT	N/A	N/A	N/A	N/A	9.30 (238)	N/A	11.80
1/3 compression	N/A	N/A	N/A	9.24 (237)	9.18 (274)	10.69 (274)	11.68
1 inch compression	N/A	N/A	N/A	N/A	9.52 (244)	N/A	12.02

All dimensions are in inches with [mm] in brackets. Certified drawings are available on request.

M100L & C100L Front
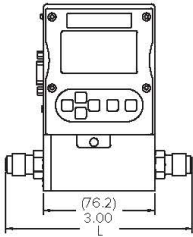
M100L & C100L Inlet

M100L & C100L Bottom
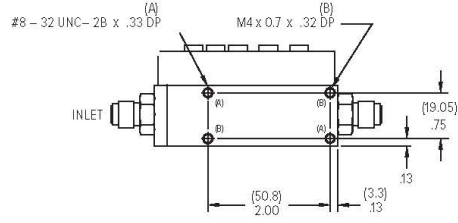
M100M Front View

M100M Inlet

M100M Bottom
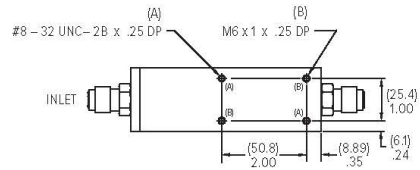
C100M Front
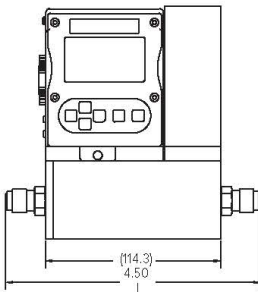
C100M Inlet
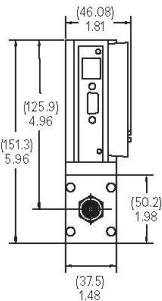
C100M Bottom
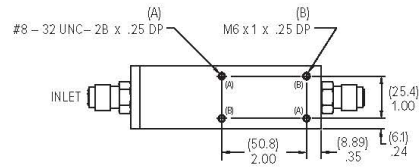
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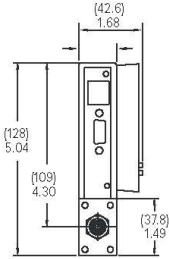
All dimensions are in inches with [mm] in brackets. Certified drawings are available on request.

M100H Front View　　**M100H Side View**　　**M100H Bottom View**
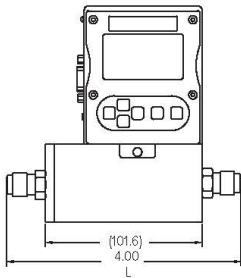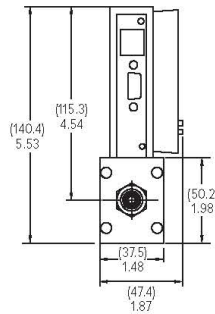
C100H Front Veiw　　**C100H Side View**　　**C100H Bottom View**

M100H1, H2 Front View　　**M100H1, H2 Side View**　　**M100H1, H2 Bottom View**

C100H1, H2 Front View　　**C100H1, H2 Side View**　　**C100H1, H2 Bottom**

Features   Options

| Parent | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1 |
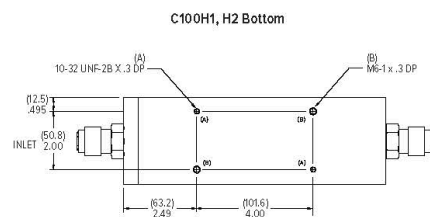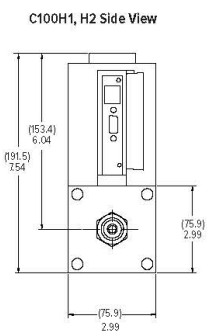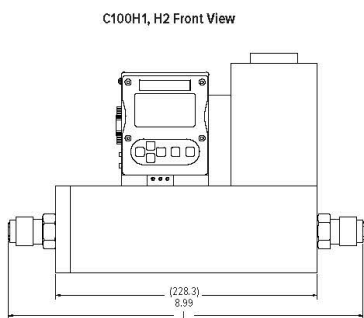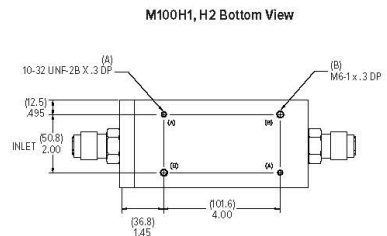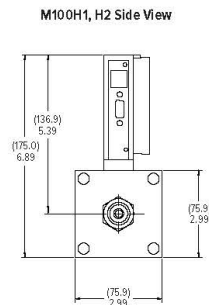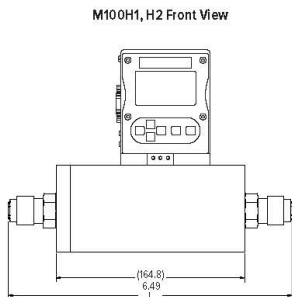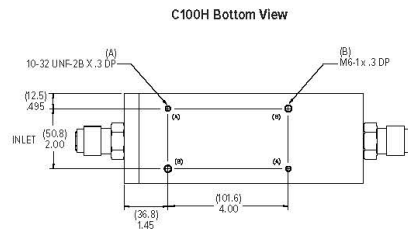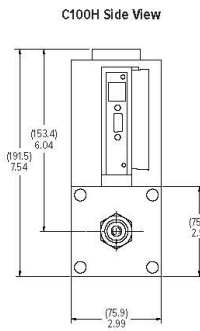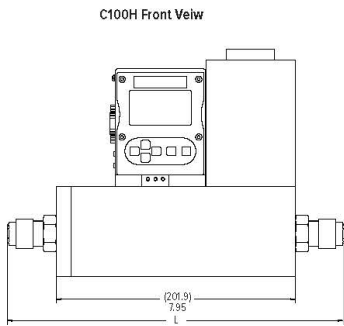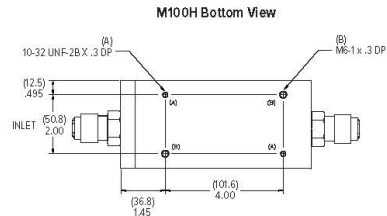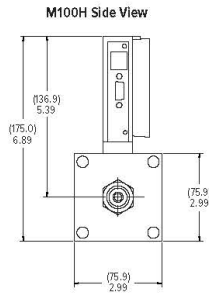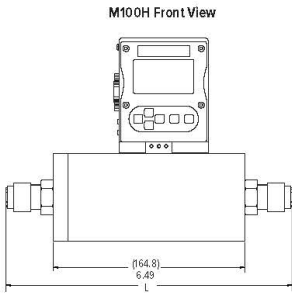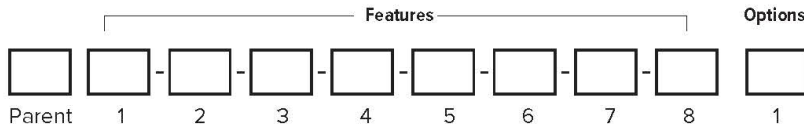
Instructions: To order a 100 please fill in each number block by selecting the codes from the corresponding features below and following pages.

Parent Number	
M100	Mass Flow Meter, Digital High Performance with Multiple Gas Capability (Dial-A-Gas®)
C100	Mass Flow Controller, Digital High Performance with Multiple Gas Capability (Dial-A-Gas®)

Feature 1:Flow Body Size*			
M100L	Low flow meter: 0-10 sccm up to 0-50 slpm	C100L	Low flow controller: 0-10 sccm up to 0-50 slpm.
M100M	Medium flow meter: 0-20 slpm up to 0-200 slpm	C100M	Medium flow controller: 0-20 slpm up to 0-200 slpm
M100H	High flow meter: 0-100 to 0-500 slpm full scale	C100H	High flow controller: 0-100 to 0-500 slpm
M100H1	High flow meter: 0-501 to 0-800 slpm full scale	C100H1	High flow controller: 0-501 to 0-800 slpm full scale
M100H2	High flow meter: 0-801 to 0-1000 slpm full scale	C100H2	High flow controller: 0-801 to 0-1000 slpm full scale

Note: All slpm flow ranges also available in nlpm *Flow bodies are sized for Air flow rates. Other gases must be converted to equivalent air flow. Use K-Factor and size accordingly. **You must select Low Flow Calibration under "Options" for 0-20 sccm full scale flow range or less.

Feature 2: Pilot Module Display	
NR	No display/interface.
DD	Pilot Module Display/Interface mounted on the enclosure
RD	Remote Display Pilot Module Display/Interface. Includes 10 foot (3 meter) CAT 5 cable. Optional cables up to 50 feet may be used. May be used with digicomms but not simultaneously
CMNR	Compod with RS-485 Modbus communication mounted on the enclosure
CMDD	Compod with RS-485 Modbus communication and Display mounted on the enclosure

Note: Only one option may be selected for Feature 2.
For all options in Feature 2, no pilot module with Compod.

Feature 3: Inlet / Outlet Fittings			
0	Customer supplies fittings	9	1/2-inch VCR. For all flow bodies up to 500 slpm. Above 500 slpm contact factory.
1	1/8-inch compression. For low flow bodies. (maximum 5 slpm)	10	6 mm Compression. For low flow bodies. (maximum 50 slpm)
2	1/4-inch compression (standard up to 30 slpm). For low flow bodies (maximum 50 slpm)	11	10 mm Compression. For low and medium bodies. (maximum 300 slpm)
3	3/8-inch compression (standard for 30 to 300 slpm). For low and medium bodies. (maximum 300 slpm)	12	12 mm Compression. For all flow bodies up to 500 slpm. Above 500 slpm contact factory.
4	1/2-inch compression For all flow bodies	13	1/4-FNPT adapter bushing (maximum 200 slpm). For low and med flow bodies.
5	1/4-inch VCO. For low flow bodies (maximum 50 slpm)	14	3/8-FNPT. For low and med flow bodies only.
6	1/2-inch VCO. For low and medium flow bodies	15	1/2-FNPT. For high flow bodies up to 500 slpm.
7	3/4-inch VCO. For H, H1, and H2 high flow bodies only	16	3/4-FNPT. For H1 and H2 high flow bodies only
8	1/4-inch VCR. For low flow bodies. (maximum 50 slpm)	17	3/4-inch compression. For H, H1, and H2 flow bodies only
9	1/2-inch VCR. For all flow bodies up to 500 slpm. Above 500 slpm contact factory.	18	1-inch compression. For H1 and H2 high flow bodies only

Feature 4: Body Elastomers	
OV1	Viton® (standard)
ON1	Neoprene®
90D-L	90D Viton® for CO_2 only
90D-M	90D Viton® for CO_2 only
90D-H	90D Viton® for CO_2 only

Note: Consult factory for other elastomers.

8 ORDERING THE SMART TRAK 100 (continued)

Feature 5: Valve Seat (MFC only)			
SV1	Viton®	SK3	Kalrez® (or equivalent for high flow bodies)
SN1	Neoprene® (or equivalent)	VX1 (low flow only)	ValFlex™ required for CO_2
SK1	Kalrez® (or equivalent for low flow bodies)	VX2 (medium flow only)	ValFlex™ required for CO_2
SK2	Kalrez® (or equivalent for medium flow bodies)	VX3 (high flow only)	ValFlex™ required for CO_2

Note: VX1, VX2, VX3; Consult factory, use CO2 Elastomer Compatibility Concentration vs. Pressure application tool to determine required elastomers for MFC valve seat.

Leak-By Disclaimer: Valflex valve seats will have leak-by rates outside of the normal C100 specifications, but should not exceed 3-5%FS, dependent on orifice size.

Feature 6: Input Power	
PV2	24 VDC for all instruments (standard)

Feature 7: Output Signal	
V1	0-5 VDC and 4-20 mA linear output signals
V2	1-5 VDC and 4-20 mA linear output signals
V3	0-10 VDC and 4-20 mA linear output signals

Note: Alternate among V1, V2, V3 with Pilot Module display/interface or SmartTrak Software

Feature 8: External Setpoint Signal (MFC only)	
S0	Pilot Module/RS-232 (standard for Pilot Module/digital operation)
S1	0-5 VDC, linear
S2	1-5 VDC, linear
S3	0-10 VDC, linear
S4	4-20 mA, linear

Note: Alternate among S0, S1, S2, S3, and S4 with Pilot Module display/interface or SmartTrak Software.

Option 1: Special Cals		
A1	High accuracy calibration, +/- 0.5% of FS at calibration conditions A1 Accuracy Statement Highest Accuracy Calibration; +/- 0.5% of F.S. (at operating conditions) only applies to the single gas used during calibration; Also includes 10 point linearization on actual gas. A1 Operating Conditions: Flow range: up to 50 slpm or nlpm (valid from 10 to 100% of the calibrated range)	Gases: Air, Nitrogen, Helium, or Argon Pressure: up to 10.3 barg (150 psig) Temperature range: 10°C to 30°C (50°F to 86°F) Orientation: horizontal only
GS	Gas substitution: One or more gases or mixtures may be substituted for 9 of the standard Dial-A-Gas gases. See application data sheet for specifics.	
LF	Low flow calibration for all C100L and M100L; required for 0 to 10 sccm -0 to 20 sccm full scale calibrations or less.	

Note: A1 option only available on a low flow body (M100L or C100L).
For other operating conditions contact factory.

Measurably Different™

Appendix B: Gas Tables & K-factors (same for all 100 Series)

SmartTrak Pre-programmed Gases: Dial-A-Gas

The following gases have been programmed into the SmartTrak instrument in this order. If you are using one of these gases, you may use the Dial-A-Gas feature in either the Pilot Module or the Software Package and the instrument will adjust the outputs automatically.

1. Air
2. Argon
3. CO2
4. CO
5. Helium
6. Hydrogen
7. Methane
8. Nitrogen
9. Nitrous Oxide
10. Oxygen

K-Factor Calculations-- Using SmartTrak with Other Gases

If you will be using SmartTrak with a gas not on this list, you may use the tables below. They provide K-factors and thermodynamic properties of gases commonly used with mass flow meters and controllers. This is particularly useful if the actual gas is not a common gas or if it is toxic, flammable, corrosive, etc. The tables can also be used to interpret the reading of a flow meter or flow controller that has been calibrated with a gas other than the actual gas.

Before applying the tables, set the instrument for Air. Then, the following fundamental relationship may be used:

$Q_1/Q_N = K_1/K_N$
Where:

Q =   The volumetric flow rate of the gas referenced to normal conditions of 0°C and 760 mm Hg (nccm or nlm),

K =   The K-factor from the following tables, referenced to Air

$( )_1$ = Refers to the "actual" gas, and

$( )_N$ = Refers to the "reference" gas, Air in this case.

Gas Tables and K-factors

> **NOTE: If no O-ring material is specified then O-ring to be used is Viton. NEO is neoprene or equivalent. KR is DuPont Kalrez or equivalent. Valve Seat applies only to controllers.**

Actual Gas	Chemical Symbol	K-factor Relative to Air	Cp (Cal/g)	Density (g/l) @ 70°F	Density (g/l) @ 0°C	Elastomers*	
						O-ring	Valve Seat
Acetylene	C_2H_2	0.581	0.4036	1.079	1.162	Viton®	Viton®
Air		1	0.24	1.2	1.293	Viton®	Viton®
Allene (Propadiene)	C_3H_4	0.431	0.352	1.659	1.787	Viton®	KR
Ammonia	NH_3	0.732	0.492	0.706	0.76	NEO	KR
Argon	Ar	1.398	0.1244	1.655	1.782	Viton®	Viton®
Arsine	AsH_3	0.671	0.1167	3.229	3.478	Viton®	KR
Boron Trichloride	BCl_3	0.411	0.1279	4.852	5.227	**Excluding the 100 Series.**	
Boron Trifluoride	BF_3	0.511	0.1778	2.808	3.025	Viton®	KR
Boron Tribromide	Br_3	0.381	0.0647	10.378	11.18	Viton®	KR
Bromine	Br_2	0.812	0.0539	6.619	7.13	Viton®	Viton®
Bromine Pentafluoride	BrF_5	0.261	0.1369	7.244	7.803	Viton®	KR
Bromine Trifluoride	BrF_3	0.381	0.1161	5.67	6.108	Viton®	KR
Bromotrifloromethane	$CBrF_3$	0.371	0.1113	6.168	6.644	Viton®	Viton®
(Freon-13 B1)						Viton®	Viton®
1,3-Butadiene	C_4H_6	0.321	0.3514	2.24	2.413	Viton®	Viton®
Butane	C_4H_{10}	0.261	0.4007	2.407	2.593	Viton®	Viton®
1-Butane	C_4H_8	0.301	0.3648	2.324	2.503	Viton®	Viton®
2-Butane	C_4H_8 CIS	0.325	0.336	2.324	2.503	Viton®	Viton®
2-Butane	C_4H_8 TRANS	0.292	0.374	2.324	2.503	Viton®	Viton®
Carbon Dioxide	CO_2	0.737	0.2016	1.835	1.964	90 D Viton®	ValFlex
Carbon Disulfide	CS_2	0.601	0.1428	3.153	3.397	Viton®	Viton®
Carbon Monoxide	CO	1.002	0.2488	1.16	1.25	Viton®	Viton®
Carbon Tetrachloride	CCl_4	0.311	0.1655	6.368	6.86	Viton®	KR
Carbon Tetrafluoride	CF_4	0.421	0.1654	3.645	3.926	Viton®	Viton®
(Freon-14)						Viton®	Viton®
Carbonyl Fluoride	COF_2	0.541	0.171	2.734	2.945	Viton®	Viton®
Carbonyl Sulfide	COS	0.661	0.1651	2.488	2.68	Viton®	Viton®
Chlorine	CL_2	0.862	0.114	2.936	3.163	**Excluding the 100 Series.**	
Chlorine Trifluoride	CIF_3	0.401	0.165	3.829	4.125	Viton®	KR
Chlorodifluoromethane	$CHCIF_2$	0.461	0.1544	3.581	3.858	Viton®	KR
(Freon-22)							
Chloroform	$CHCl_3$	0.391	0.1309	4.944	5.326	Viton®	KR
Chloropentafluoroethane	C_2CIF_5	0.241	0.164	6.398	6.892	Viton®	KR
(Freon-115)							
Chlorotrifluromethane	$CCIF_3$	0.381	0.153	4.326	4.66	Viton®	KR
(Freon-13)							

Actual Gas	Chemical Symbol	K-factor Relative to Air	Cp (Cal/g)	Density (g/l) @ 70°F	Density (g/l) @ 0°C	Elastomers*	
						O-ring	Valve Seat
Cyanogen	C_2N_2	0.611	0.2613	2.156	2.322	Viton®	KR
Cyanogen Chloride	ClCN	0.611	0.1739	2.545	2.742	KR	KR
Cychlopropane	C_3H_5	0.461	0.3177	1.742	1.877	Viton®	KR
Deuterium	D_2	1.002	0.1722	1.67	1.799	Viton®	Viton®
Diborane	B_2H_6	0.441	0.508	1.147	1.235	Viton®	KR
Dibromodifluoromethane	CBr_2F_2	0.19	0.15	8.691	9.362	Viton®	KR
Dibromethane		0.471	0.075	7.204	7.76	Viton®	KR
Dichlorodifluoromethane (Freon-12)	CCl_2F_2	0.351	0.1432	5.008	5.395	Viton®	KR
Dichlorofluoromethane (Freon-21)	$CHCl_2F$	0.421	0.14	4.597	4.952	Viton®	KR
Dichloromethylsilane	$(CH_3)_2SiCl_2$	0.251	0.1882	5.345	5.758	Viton®	KR
Dichlorosilane	SiH_2Cl_2	0.401	0.15	4.183	4.506	Viton®	KR
Dichlorotetrafluoroethane (Freon-114)	$C_2Cl_2F_4$	0.22	0.1604	7.079	7.626	Viton®	KR
1,1-Difluoroethylene (Freon-1132A)	$C_2H_2F_2$	0.185	0.224	2.652	2.857	Viton®	KR
Dimethylamine	$(CH_3)_2NH$	0.371	0.366	1.867	2.011	Viton®	KR
Dimethyl Ether	$(CH_3)_2O$	0.391	0.3414	1.908	2.055	Viton®	KR
2,2-Dimethylpropane	C_3H_{12}	0.22	0.3914	2.988	3.219	Viton®	KR
Ethane	C_2H_6	0.501	0.4097	1.246	1.342	Viton®	Viton®
Ethanol	C_2H_6O	0.391	0.3395	1.908	2.055	Viton®	KR
EthylAcetylene	C_4H_6	0.321	0.3513	2.24	2.413	Viton®	KR
Ethyl Chloride	C_2H_5Cl	0.391	0.244	2.673	2.879	Viton®	KR
Ethylene	C_2H_4	0.601	~.358	1.161	1.251	Viton®	Viton®
Ethylene Oxide	C_2H_4O	0.521	0.268	1.824	1.965	Excluding the 100 Series.	
Fluorine	F_2	0.982	0.1873	1.574	1.695	Excluding the 100 Series.	
Fluoroform (Freon-23)	CHF_3	0.501	0.176	2.903	3.127	Viton®	KR
Freon-11	CCl_3F	0.331	0.1357	5.69	6.129	Viton®	KR
Freon-12	CCl_2F_2	0.351	0.1432	5.008	5.395	Viton®	KR
Freon-13	$CClF_3$	0.381	0.153	4.326	4.66	Viton®	KR
Freon-13	B1 $CFrF_3$	0.371	0.1113	6.168	6.644	Viton®	KR
Freon-14	CF_4	0.421	0.1654	3.645	3.926	Viton®	Viton®
Freon-21	$CHCl_2F$	0.421	0.14	4.597	4.952	Viton®	KR
Freon-22	$CHClF_2$	0.461	0.1544	3.581	3.858	Viton®	KR
Freon-113	CCl_2FCClF_2	0.2	0.161	7.761	8.36	Viton®	KR
Freon-114	$C_2Cl_2F_4$	0.22	0.16	7.079	7.626	Viton®	KR
Freon-115	C_2ClF_5	0.241	0.164	6398	6.892	Viton®	KR
Freon-C318	C_4F_8	0.17	0.185	7.795	8.397	NEO	NEO
Germane	GeH_4	0.571	0.1404	3.173	3.418	Viton®	Viton®
Germanium Tetrachloride	$GeCL_4$	0.271	0.1071	8.879	9.565	Viton®	KR
Helium	He	1.399	1.241	0.164	0.1786	Viton®	Viton®

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Actual Gas	Chemical Symbol	K-factor Relative to Air	Cp (Cal/g)	Density (g/l) @ 70°F	Density (g/l) @ 0°C	Elastomers*	
						O-ring	Valve Seat
Hexafluoroethane (Freon-116)	C_2F_6	0.241	0.1834	5.716	6.157	Viton®	KR
Hexane	C_6H_{14}	0.18	0.3968	3.569	3.845	Viton®	KR
Hydrogen	H_2	1.001	3.419	0.083	0.0899	Viton®	Viton®
Hydrogen Bromide	HBr	1.002	0.0861	3.351	3.61	Viton®	KR
Hydrogen Chloride	HCl	1.002	0.1912	1.51	1.627	Excluding the 100 Series.	
Hydrogen Cyanide	HCN	1.072	0.3171	1.12	1.206		KR
Hydrogen Fluoride	HF	1.002	0.3479	0.829	0.893	Excluding the 100 Series.	
Hydrogen Iodide	HI	1.002	0.0545	5.298	5.707	Viton®	KR
Hydrogen Selenide	H_2Se	0.792	0.1025	3.354	3.613	Viton®	KR
Hydrogen Sulfide	H_2S	0.802	0.2397	1.411	1.52	NEO	KR
Iodine Pentafluoride	IF_5	0.251	0.1108	9.19	9.9	Viton®	KR
Isobutane	$CH(CH_3)_3$	0.271	0.3872	3.335	2.593	Viton®	KR
Isobutylene	C_4H_8	0.291	0.3701	2.324	2.503	Viton®	KR
Krypton	Kr	1.456	0.0593	3.471	3.739	Viton®	Viton®
Methane	CH_4	0.754	0.5328	0.665	0.715	Viton®	Viton®
Methanol	CH_3OH	0.581	0.3274	1.327	1.429	Viton®	Viton®
Methyl Acetylene	C_3H_4	0.431	0.3547	1.659	1.787	Viton®	KR
Methyl Bromide	CH_3Br	0.581	0.1106	3.932	4.236	Viton®	Viton®
Methyl Chloride	CH_3Cl	0.193	2.253	2.092		Viton®	KR
Methyl Fluoride	CH_3F	0.681	0.3221	1.409	1.518	Viton®	KR
Methyl Mercaptan	CH_3SH	0.521	0.2459	1.992	2.146	Viton®	KR
Methyl Trichlorosilane	$(CH_3)SiCl_3$	0.251	0.164	6.191	6.669	Viton®	KR
Molybdenum Hexafluoride	MoF_6	0.21	0.1373	8.695	9.366	Viton®	KR
Monoethylamine	$C_2H_5NH_2$	0.351	0.387	1.867	2.011	Viton®	KR
Monomethylamine	CH_3NH_2	0.511	0.4343	1.287	1.386	Viton®	KR
Neon	NE	1.463	0.245	0.836	0.9	Viton®	Viton®
Nitric Oxide	NO	0.992	0.2328	1.243	1.339	Viton®	Viton®
Nitrogen	N_2	1.002	0.2485	1.161	1.25	Viton®	Viton®
Nitrogen Dioxide	NO_2	0.742	0.1933	1.905	2.052	Excluding the 100 Series.	
Nitrogen Trifluoride	NF_3	0.481	0.1797	2.941	3.168	Viton®	KR
Nitrosyl Chloride	NOCl	0.611	0.1632	2.711	2.92	Viton®	KR
Nitrous Oxide	N_2O	0.716	0.2088	1.836	1.964	Viton®	
Octafluorocyclobutane (Freon-C318)	C_4F_8	0.17	0.185	7.795	8.397	Viton®	KR
Oxygen Difluoride	OF_2	0.631	0.1917	2.234	2.406	Viton®	Viton®
Oxygen	O_2	0.998	0.2193	1.326	1.427	Viton®	Viton®
Ozone	O_3	0.447	0.3	1.99	2.144	Viton®	Viton®
Pentaborane	B_5H_9	0.261	0.38	2.614	2.816	Viton®	KR
Pentane	C_5HI_2	0.21	0.398	2.988	3.219	Viton®	KR
Perchloryl Fluoride	ClO_3F	0.391	0.1514	4.243	4.571	Viton®	KR
Perfluoropropane	C_3F_8	0.174	0.197	7.787	8.388	Viton®	KR

Actual Gas	Chemical Symbol	K-factor Relative to Air	Cp (Cal/g)	Density (g/l) @ 70°F	Density (g/l) @ 0°C	Elastomers*	
						O-ring	Valve Seat
Phosgene	$COCl_2$	0.441	0.1394	4.101	4.418	Viton®	KR
Phosphine	PH_3	0.762	0.2374	1.408	1.517	Viton®	KR
Phosphorous Oxychloride	$POCl_3$	0.361	0.1324	6.352	6.843	Viton®	KR
Phosphorous Pentafluoride	PH_5	0.301	0.161	5.217	5.62	Viton®	KR
Phosphorous Trichloride	PCl_5	0.301	0.125	5.688	6.127	Viton®	KR
Propane	C_3H_8	0.335	0.3885	1.826	1.967	Viton®	Viton®
Propylene	C_3H_6	0.411	0.3541	1.742	1.877	Viton®	Viton®
Silane	SiH_4	0.601	0.3189	1.33	1.433	Viton®	KR
Silicon Tetrachloride	$SiCl_4$	0.281	0.127	7.037	7.58	Viton®	KR
Silicon Tetrafluoride	SiF_4	0.351	0.1691	4.31	4.643	Viton®	KR
Sulfur Dioxide**	SO_2	0.691	0.1488	2.653	2.858	Viton®	KR NOTE: Limited Warranty on SO_2
Sulfur Hexafluoride	SF_6	0.261	0.1592	6.049	6.516	Viton®	
Sulfuryl Fluoride	SO_2F_2	0.391	0.1543	4.235	4.562	Viton®	KR
Tetraethyl Orthosilicate	Teos	0.09				Excluding the 100 Series.	
Tetrafluorahydrazine	N_2F_4	0.321	0.182	4.307	4.64	Viton®	KR
Trichlorofluormethane (Freon-11)	CCl_3F	0.331	0.1357	5.69	6.129	Viton®	KR
Trichlorisilane	$SiHCl_3$	0.331	0.138	5.61	6.043	Viton®	KR
1,1,2-Trichloro-1,2,2 Trifluorethane (Freon-113)	CCl_2FCClF_2	0.2	0.161	7.761	8.36	Viton®	KR
Trisobutyl Aluminum	$(C_4H_9)Al$	0.061	0.508	8.214	8.848	Viton®	KR
Titanium Tetrachloride	$TiCl_4$	0.271	0.12	7.858	8.465	Viton®	KR
Trichloro Ethylene	C_2HCl_3	0.321	0.163	5.523	5.95	Viton®	KR
Trimethylamine	$(CH_3)_3N$	0.281	0.371	2.45	2.639	Viton®	KR
Tungsten Hexasfuoride	WF_6	0.251	0.081	12.328	13.28	Excluding the 100 Series.	
Uranium Hexafluoride	UF_6	0.2	0.0888	14.574	15.7	Viton®	KR
Vinyl Bromide	CH_2CHBr	0.461	0.1241	4.43	4.772	Viton®	KR
Vinyl Chloride	CH_2CHCl	0.481	0.1205	2.588	2.788	Viton®	KR
Xenon	Xe	1.443	0.0378	5.438	5.858	Viton®	Viton®

Appendix C: Flow Chart for Pilot Module User Interface (same for all 100 Series)
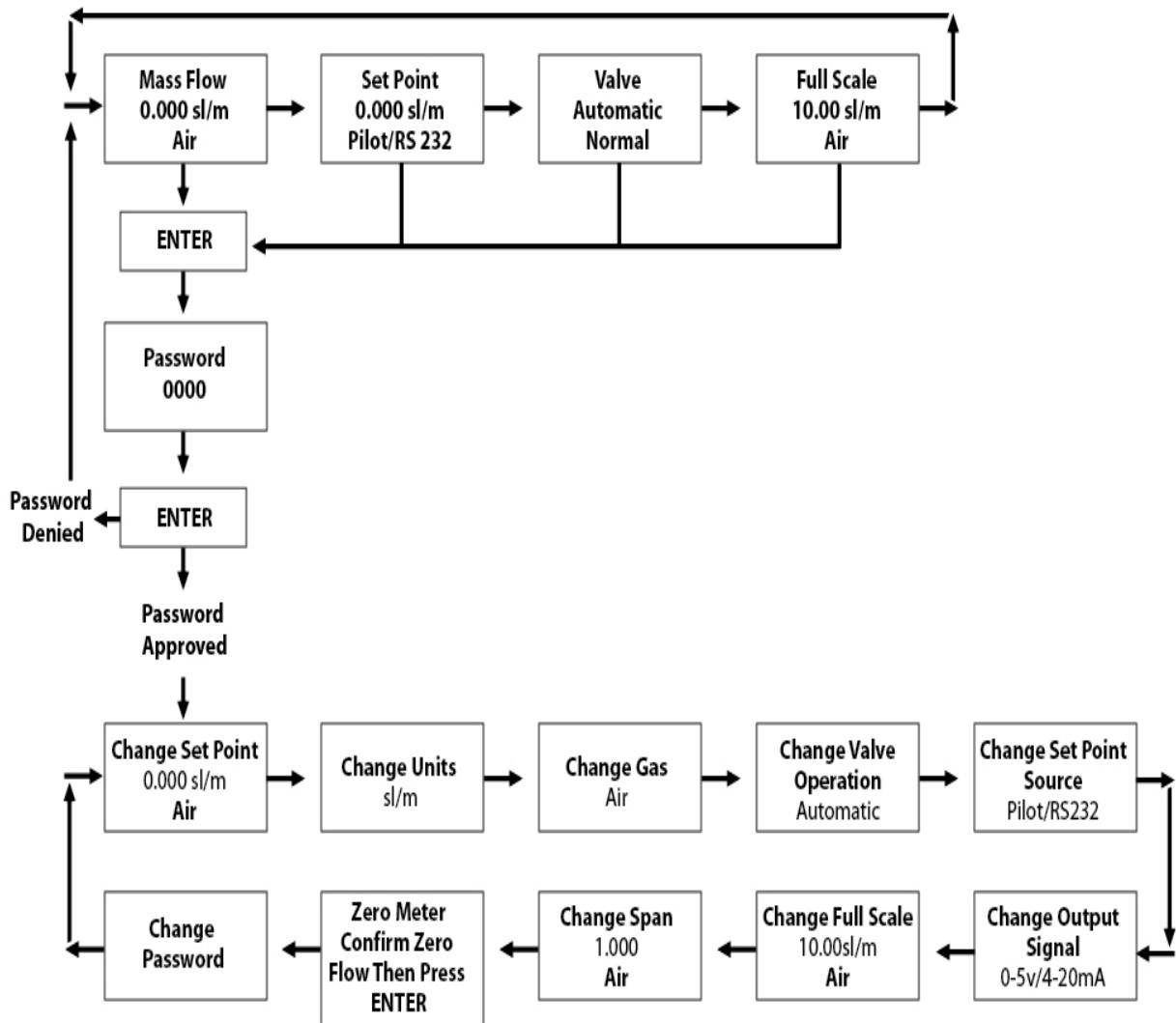
NOTE: If you press the escape key at any time, you will immediately return to the main Mass Flow screen in the Upper Level.

Appendix D: PIN Configuration (same for all 100 Series)

Figure 2-4: Wiring Definitions for Optional Communication Cable

Pin #	Wire Color in Cable	Function
1.	Brown	Analog Ground/Output
2.	Red	0-5 VDC Output (or 0-10, 1-5 VDC)
3.	Orange	Analog Ground/RS232
4.	Pink	Valve Override Purge
5.	Yellow	Power Return (-)
6.	Green	Power Input (+)
7.	Green/White	RS-232 Transmit (out)
8.	Blue	Setpoint
9.	Purple	Not Used
10.	Gray	Analog Ground/Setpoint
11.	White	Reference Voltage (5 VDC External Setpoint & Valve Purge)
12.	Black	Valve Override Close
13.	Brown/white	RS-232 Receive (in)
14.	Red/white	0/4-20 mA Output
15.	Red/Black	Not Used
	Shield Wire (no insulation)	Chassis (Earth) Ground

NOTE: Pins 1, 3, and 10 are connected together inside the instrument. Do not tie these grounds together outside the instrument. Must have one connection per analog ground. Recommended use listed.

NOTE: Unused cable wires should be isolated and insulated from one another or damage could occur.

Appendix E: SmartTrak Basic Commands (same for all 100 Series)

IMPORTANT CUSTOMER NOTICE
This document is for firmware version 2.044. Sierra Instruments, Inc. reserves the right to change the command set without notification to the user. However, Sierra will also make every effort to maintain backwards compatibility with previously published command sets for SmartTrak®. There is no implied warranty or guarantee regarding the use of this commands set. Sierra Instruments, Inc. is not liable for any damage or personal injury, whatsoever, resulting from the use of this command set.

PROTOCOL
The SmartTrak communication is based on a standard RS232 port. All bytes are ASCII except the two CRC bytes used for a redundancy check.   Each command starts with four bytes of command type, followed by a variable length value section. The two CRC bytes follow the value string and a carriage return ends the string. Each command string will vary in length but, can not exceed 26 bytes.
Command String = {4 command bytes + variable length value + 2 CRC bytes + carriage return} < 26 bytes.

The RS232 port does not depend on hardware handshaking and uses only three wires on the port: transmit, receive and ground. The port on the host needs to be configured to (9600,n,8,1) : 9600 baud, no parity, eight bit characters, one stop bit.

DESCRIPTION
Commands for the Meter. There are SmartTrak commands (version 1.xx), SmartTrak 2 commands (version 2.xx), and SmartTrak 100 commands (2.xx). The 2.xx commands will support some of the 1.xx commands. If a 1.xx commands is not shown below, it is not supported in the 2.xx commands. CMNDS is a class included in the class of Meter. This page shows all types, fields, and values as derived from Meter. Version 2.xx commands that start with a '?' are read commands and commands that start with a '!' are write commands. This is list of the most commonly used commands, which are relative safe.

FLOW
DESCRIPTION
FLOW makes the streaming mode data = flow only. If meter is in streaming mode, this data will stream until a FLOWwSETPOINT, FLOWwSETPOINTwDAC or TOTALwDIFFwDAC is sent to the meter. If not in streaming mode then one flow will be return with each FLOW command sent. ReadMeter, WriteMeter both will set flow as the streaming data.

ASCII STRING COMMANDS

'?Flow + CRC + cr' Version 2.xx read command
'!Flow + value + CRC + cr' Version 2.xx write command
'?Flow + CRC + cr' Version 1.xx read command

Returns ASCII string 'Flow + value + CRC + cr'

Values are a string of digits and an optional decimal place: '10.00'

SETPOINT

DESCRIPTION
SETPOINT sets the control setpoint. The set point is store in the flash memory. This command is not recommended for version 2.xx,. Use SETPOINT_FLASH.

ASCII STRING COMMANDS

'?Sinv + CRC + cr' Version 2.xx read command
'!Sinv + value + CRC + cr' Version 2.xx write command
'?Sinv + CRC + cr' Version 1.xx read command
'Sinv + value + CRC + cr' Version 1.xx write command

Returns ASCII string 'Sinv + valueSetpoint + CRC + cr'

Values are a string of digits and an optional decimal place: '10.00'
CRC=redundancy check bytes; cr=carrage return byte.

SETPOINT_FLASH
DESCRIPTION
SETPOINT_FLASH returns the current flash memory value setpoint with read command. The write command sets the flash memory value and makes it the active setpoint. This would be the setpoint after a power down.

ASCII String commands

'?Setf + CRC + cr' Version 2.xx read command
'!Setf + value + CRC + cr' Version 2.xx write command

Returns ASCII string 'Setf + valueSetpoint + CRC + cr'

Values are a string of digits and an optional decimal place: '10.00'
CRC=redundancy check bytes; cr=carrage return byte.

SETPOINT_RAM

DESCRIPTION

SETPOINT_RAM returns the current ram memory value setpoint with read command. The write command sets the ram memory value and makes it the active setpoint.

ASCII STRING COMMANDS

'?Setr + CRC + cr' Version 2.xx read command
'!Setr + value + CRC + cr' Version 2.xx write command

Read returns ASCII string 'Setr + valueSetpoint + CRC + cr'

Write returns ASCII string 'Sinv + valueSetpoint + CRC + cr'

Values are a string of digits and an optional decimal place: '10.00'
CRC=redundancy check bytes; cr=carrage return byte.

UNIT_INDEX

DESCRIPTION

UNIT_INDEX selects the units the meter displays. The index value is between 1 and 30 and is assigned as shown. scc/s = 1, scc/m = 2, scc/H = 3, Ncc/s = 4, Ncc/m = 5, Ncc/H = 6, SCF/s = 7, SCF/m = 8, SCF/H = 9, NM3/s = 10, NM3/m = 11, NM3/H = 12, SM3/s = 13, SM3/m = 14, SM3/H = 15, sl/s = 16, sl/m = 17, sl/H = 18, NL/s = 19, NL/m = 20, NL/H = 21, g/s = 22, g/m = 23, g/H = 24, kg/s = 25, kg/m = 26, kg/H = 27, lb/s = 28, lb/m = 29, lb/H = 30

ASCII STRING COMMANDS

'?Unti + CRC + cr' Version 2.xx read command
'!Unti + unitIndex + CRC + cr' Version 2.xx write command
'?Unti + CRC + cr' Version 1.xx read command
'Unti + unitIndex + CRC + cr' Version 1.xx write command

Returns ASCII string 'Unti + unitIndex + CRC + cr'

unitIndex is an integer string value of 1 to 30
CRC=redundancy check bytes; cr=carrage return byte.

VALVE_INDEX

DESCRIPTION

VALVE_INDEX selects the state of the valve. Automatic = 1, Closed = 2, Purge = 3. This is a write to flash memory command. For version 2.xx, this command is not recommended. See VALVE_FLASH_INDEX and VALVE_RAM_INDEX.

ASCII STRING COMMANDS

'?Vlvi + CRC + cr' Version 2.xx read command
'!Vlvi + valveIndex + CRC + cr' Version 2.xx write command
'?Vlvi + CRC + cr' Version 1.xx read command
'Vlvi + valveIndex + CRC + cr' Version 1.xx write command

Returns ASCII string 'Vlvi + valveIndex + CRC + cr'

valveIndex is an integer string value of 1 to 3
CRC=redundancy check bytes; cr=carrage return byte.

GAS_INDEX
DESCRIPTION
GAS_INDEX selects the current gas.

ASCII STRING COMMANDS

'?Gasi + CRC + cr' Version 2.xx read command
'!Gasi + gasIndex + CRC + cr' Version 2.xx write command
'?Gasi + CRC + cr' Version 1.xx read command
'Gasi + gasIndex + CRC + cr' Version 1.xx write command

Returns ASCII string 'Gasi + gasIndex + CRC + cr'

gasIndex value is 1 through 10
CRC=redundancy check bytes; cr=carrage return byte.

STREAM
DESCRIPTION
Communications can be in one of three mode set by this STREAM command. In off mode, the meter will respond when queried with a read command. In echo mode, the meter will respond with either a read or a write command. In stream mode, the meter will continuously send data back. If a read or write command needs to update more than one value, all values with be sent back on write command.

ASCII STRING COMMANDS

'?Strm + CRC + cr' Version 2.xx read command
'!Strm + streamString + CRC + cr' Version 2.xx write command
Returns ASCII string 'Strm + streamString + CRC + cr'

streamString = "On", "Off", "Echo"
CRC=redundancy check bytes; cr=carrage return byte.

VERSION_NUMBER
DESCRIPTION
VERSION_NUMBER returns the firmware version. This is useful when Ver. 1.xxx and 2.xxx are in the same system to determine which command to send.

ASCII STRING COMMANDS

'?Vern + CRC + cr' Version 2.xx read command

Returns ASCII string 'Vern + alphaNumericString + CRC + cr'

alphaNumericString is alpha numeric string
CRC=redundancy check bytes; cr=carrage return byte.

SERIAL_NUMBER
DESCRIPTION
SERIAL_NUMBER returns the serial number

ASCII STRING COMMANDS

'?Srnm + CRC + cr' Version 2.xx read command

Returns ASCII string 'Srnm + SERIAL_NUMBER + CRC + cr'

alphaNumericString is alpha numeric string
CRC=redundancy check bytes; cr=carrage return byte.

SYNC
DESCRIPTION
Sync returns the following events, VersionNumberEvent, SerialNumberEvent, DataEvent, ManufactureNumberEvent, TypeEvent, PassWordEvent, SetpointEvent, FullScaleEvent, GasNameEvent(10 times for all gas names), GasIndexEvent, GasSpanEvent(current gas only), SetpointIndexEvent, OuputIndexEvent, UnitIndexEvent, ValveFlashEvent, StreamEvent, SyncEvent

ASCII STRING COMMANDS

'?Sync + CRC + cr' Version 2.xx read command

Returns ASCII string 'Sync + "" + CRC + cr'

SyncEvent returned last to indicate all events have been sent
CRC=redundancy check bytes; cr=carrage return byte.

ZERO
DESCRIPTION
ZERO sets the flow offset value to a zero flow reading. Warning: All flow must be shut off, the unit needs to be at pressure with the gas being used.

ASCII STRING COMMANDS

'!Zero + "" + CRC + cr' Version 2.xx write command

CRC=redundancy check bytes; cr=carrage return byte.

RESET_ZERO
DESCRIPTION
Reset zero flow offset value to zero

ASCII STRING COMMANDS

'!Rezr + "" + CRC + cr' Version 2.xx write command

Returns ASCII string 'Rezr + "" + CRC + cr'

CRC=redundancy check bytes; cr=carrage return byte

CRC CALCULATIONS

Below is the routine used to calculate the CRC bytes in C#.
Comments are between the /*   */.

```
            private static uint CalcCRC(byte[] cmnd)
/* cmnd is a byte array containing the command ASCII string … cmnd[]="Sinv2.000" */
/* An unsigned 32 bit integer is return to the calling program */
/* only the lower 16 bits contain the crc */
        {
                int i,j;  /* interating indexes for the for loops */
                uint crc;         /* crc variable that will be returned */

                crc=0xffff;      /* initialize crc to hex value 0xffff */

                for (i=0; i<cmnd.Length; i++)
```

/* this for loop starts with ASCCII 'S' and loops through to the last ASCII '0' */
```
                {
                        crc=crc^((uint)(cmnd[i]*0x0100));
```
/* the ASCII value is times by 0x0100 first then XORED to the current crc value */
```
                        for(j=0; j<8; j++)
```
/* the crc is hashed 8 times with this for loop */
/* if the 15th bit is set (tested by ANDING with hex 0x8000 and testing for 0x8000 result) then crc is shifted left one bit (same as times 2) XORED with hex 0x1021 and ANDED to hex 0xffff to limit the crc to lower 16 bits. If the 15th bit is not set then the crc is shifted left one bit and ANDED with hex 0xffff to limit the crc to lower 16 bits. */
```
                        {
                                if((crc&0x8000)==0x8000)
                                        crc=((crc<<1)^0x1021)&0xffff;
                                else
                                        crc=(crc<<1)&0xffff;
```
/* end of j loop */   }
/* end of i loop */   }
/* There are some crc values that are not allowed, 0x00 and 0x0d */
/* These are byte values so the high byte and the low byte of the crc must be checked and incremented if the bytes are either 0x00 0r 0x0d. */
```
                        if((crc&0xff00)==0x0d00) crc +=0x0100;
                        if((crc&0x00ff)==0x000d) crc +=0x0001;
                        if((crc&0xff00)==0x0000) crc +=0x0100;
                        if((crc&0x00ff)==0x0000) crc +=0x0001;
                        return crc;
                }
```
/* If the string Sinv2.000 is sent through this routine the crc = 0x8f55 */
/* The complete command "Sinv2.000" will look like this in hex
 0x53 0x69 0x6E 0x76 0x32 0x2e 0x30 0x30 0x30 0x8f 0x55 0x0d */

Below is the c# routine with no comments.

```
                private static uint CalcCRC(byte[] cmnd)
                {
                        int i,j;
                        uint crc;

                        crc=0xffff;
                        for (i=0; i<cmnd.Length; i++)
                        {
                                crc=crc^((uint)(cmnd[i]*0x0100));
                                for(j=0; j<8; j++)
                                {
                                        if((crc&0x8000)==0x8000)
                                                crc=((crc<<1)^0x1021)&0xffff;
                                        else
```

```
                                        crc=(crc<<1)&0xffff;
                                }
                        }
                        if((crc&0xff00)==0x0d00) crc +=0x0100;
                        if((crc&0x00ff)==0x000d) crc +=0x0001;
                        if((crc&0xff00)==0x0000) crc +=0x0100;
                        if((crc&0x00ff)==0x0000) crc +=0x0001;
                        return crc;
```

CRC ROUTINE IN MS VISUAL BASIC:

```
Public Sub SendPacket(packet As String)
Dim crcBytes() As Byte
Dim crcLen, vpacket
Dim crcWord As Long
Dim i, j

    packet = Replace(packet, ",", ".") ' if commas are used as decimal place holder
    crcLen = Len(packet) - 1    ' zero based counter
    ReDim crcBytes(0 To crcLen)
    For i = 0 To crcLen ' convert string to bytes
        crcBytes(i) = Asc(Mid(packet, i + 1, 1)) ' get character
    Next
' calc crc
        crcWord = (&H1FFFE) / 2 ' not -1
        For j = 0 To crcLen
            crcWord = crcWord Xor CLng(crcBytes(j)) * &H100
            For i = 1 To 8
                If (crcWord And &H8000) Then
                    crcWord = (crcWord * 2) Xor &H1021 ' prime number
                Else
                    crcWord = crcWord * 2
                End If
                crcWord = (((crcWord * 2) And &H1FFFE)) / 2
            Next i
        Next j
        If (crcWord And &HFF00) = &HD00 Then    ' carriage char not allowed
            crcWord = crcWord + &H100         ' make this byte &h0exx
        End If
        If (crcWord And &HFF00) = &H0 Then      ' zero char is death
            crcWord = crcWord + &H100         ' make this byte &h01xx
        End If
        If (crcWord And &HFF) = &HD Then        ' carriage char not allowed
            crcWord = crcWord + 1             ' make this byte &hxx0e
        End If
```

```
      If (crcWord And &HFF) = &H0 Then        ' zero char is death
         crcWord = crcWord + 1              ' make this byte &hxx01
      End If

  ReDim Preserve crcBytes(0 To crcLen + 3) ' make room for crc and carriage return
      crcBytes(crcLen + 1) = Int(crcWord / &H100) ' high byte
      crcBytes(crcLen + 2) = (crcWord And &HFF)   ' low byte
      crcBytes(crcLen + 3) = 13   ' carriage return
      vpacket = crcBytes
    commQueue.Add vpacket
      End Sub
```

Appendix F: Warranty Policy

<u>LIMITED WARRANTY POLICY- REGISTER ONLINE</u>

All Sierra products are warranted to be free from defects in material and workmanship and will be repaired or replaced at no charge to Buyer, provided return or rejection of product is made within a reasonable period but no longer than one (1) year for calibration and non-calibration defects, from date of delivery. To assure warranty service, customers must register their products online on Sierra's website. Online registration of all of your Sierra products is required for our warranty process. Register now at www.sierrainstruments.com/register. Learn more about Sierra's warranty policy at www.sierrainstruments.com/warranty