# Sierra Series 900
# Flo-Box™ System Unit

## Instruction Manual

Part Number IM-90-FB
07/05 Revision D.1

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## CUSTOMER CAUTION
## RE: OXYGEN SERVICE

Sierra Instruments, Inc., is not liable for any damage or personal injury, whatsoever, resulting from the use of Sierra Instruments mass flow meters or controllers for oxygen gas. Although Sierra cleans its mass flow meters and controllers prior to shipment, we make no claim or warranty that their cleanliness renders them safe for oxygen service. The customer must clean Sierra Instruments mass flow meters or controllers to the degree required for the customer's oxygen flow applications.

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# GETTING STARTED

## Field Adjustment of Flo-Box Zero and Span Controls

Flo-Box has internal zero and span controls for each channel. These controls do not normally need adjustment and are precisely calibrated at the factory using primary laboratory standards of flow. In the case of a field installation, a laboratory flow calibration standard is usually not available. This makes calibration of the entire system difficult and is the principle cause of inaccuracies introduced by field adjustment.

In the unlikely event that field adjustment of these controls is necessary, and in the absence of a laboratory flow standard, it is recommended that the flow signals be simulated by applying the correct electrical signals at the 20-pin Flo-Box inputs and adjusting the Flo-Box zero and span controls accordingly. The electrical inputs will generally be either 0-5 volts or 4-20 mA.

The following entire procedure should be read before starting the field adjustment.

## Accessing Zero and Span Pots

The zero and span pots for each channel are located internally. The front bezel must first be removed by unscrewing the four black screws holding it in place then sliding the top cover forward to expose the main printed circuit board (PCB). Be sure not to lose the screws.

The ZERO pots are labeled R40-1 through R40-5. R40-1 is the channel one control and is located nearest the center of the PCB. The dash number (–2, –3, –4, –5) is the channel number and the pots form a line. R40-5 is the pot nearest the edge of the PCB. The silkscreen legend identifies these pots.

The SPAN pots are labeled R42-1 through R42-5. These pots are near the zero pots and are also identified on the PCB. Again, R42-1 is the pot nearest the center of the PCB and R42-5 is the pot nearest the edge of the PCB.

## Adjusting Zero

First determine if the zero needs to be adjusted. Turn on the system and allow it to warm up thirty minutes making sure that the flow through transducers is zero. At the end of this time, check each channel for zero reading.

If the display for a channel is zero, then the zero control is properly calibrated and should not be adjusted.

If the reading is not zero, then turn R40 for each non-zero channel until zero is just reached.

Check that all channels now read zero.

The zero pots are now adjusted.

## Adjusting Plan

Span adjustment entails disconnecting the transducers from the system and injecting an electrical signal equal to the full scale value into the 20-pin transducer connectors on the back panel.

The electrical signal necessary to simulate full scale for a 0-5 volt transducer is 5.000 volts and for a 4-20 mA transducer a 4475 ohm 1% 1/4 watt resistor generates the necessary 20 mA. The type of transducer can be checked by reading the label on the side of the transducer.

First, turn off power and disconnect transducers. Then, turn power back on.

In the case of 0-5 volt transducers, connect the +5.000 volt signal to pin 3 of the 20-pin connector (see Flo-Box manual Appendix B) and the 5.000 volt common to pin-2. In the case of 4-20 mA transducers, connect a 475 ohm 1% resistor from pin 9 of the 20-pin connector (see Appendix B) to pin-2.

Next, adjust the SPAN pot, R42, for each channel until full scale is just reached.

For some transducers, full scale cannot be reached due to linearization errors. However, a reading within specification can be attained. Do not continue turning the span control beyond the point where the display stops changing.

Field adjustment of SPAN and ZERO is now complete. Turn off power to the system and reinstall the front panel bezel.

# 1 INTRODUCTION

The Sierra Instruments, Inc. Flo-Box is a highly integrated systems solution to flow measurement and control.

One to five independent flow meters or controllers can be operated from the flow computer.

Linear operation with LCD readout is standard. The alphanumeric LCD reads out directly in units of measurement. "FLO1 = 100 SLPM" and "SET1 = 100 SLPM" are examples of possible readouts on the LCD. Its English language display contributes to unambiguous operation and a high level of confidence. The back panel flow value outputs of 0-5 VDC and 4-20 mA are linear 0-100% analogs of the flow range. Both voltage and current outputs are simultaneously available.

Flow setpoint for controllers is from either the front panel pots or a remote source via the back panel I/O interface.

Side-Trak controllers also incorporate valve purge/monitor/off functions accessible from the back panel I/O connector.

Each channel has a high and low alarm (open collector) output. These alarm points are under Flo-Box control and can be read out on the front panel display for ease of adjustment.

An optional built-in totalizer displays the total mass flow of each channel as well as the elapsed time since totalization began. Battery back-up makes the totalizer highly immune to power line interruptions.

The power supply is a linear (non-switching) laboratory quality unit capable of supplying power to five channels simultaneously.

# 2 CHOOSING A LOCATION FOR FLO-BOX

The Flo-Box should be located in a room-temperature location which is dry and dust free. Try to minimize cable lengths to transducers.

Extremes of temperature and direct sunlight should be avoided.

Try to choose a location which allows the readout to be easily viewed.

# 3 FRONT PANEL FUNCTIONS

The front panel controls of the Flo-Box offer powerful functions while being easy to operate. To get the most benefit from a Sierra Instruments, Inc. Flo-Box System, read through these sections before attempting operation.

## 3.1 Channel Selection

To select the channel for display momentarily press the push button labeled "Channel Select". For normal display formats there is always an indication which channel's data is being shown. This indication always rolls over in a cyclical sequence. For example, on a 5-channel unit this would occur 1-2-3-4-5-1.

## 3.2 Reading Flow Value

The flow value is normally displayed on the LCD alphanumeric display. One of the most powerful features of Flo-Box is the sophisticated English language format of the display. The following table shows various displays possible:

| DISPLAY FUNCTION | EXAMPLES OF DISPLAY |
|---|---|
| Flow Value | "FLO1 = 100 SLPM" |
| | "FLO2 = 225 SCCM" |
| | "FLO3 = 25.0 CFM" |
| | "FLO4 = 10.5 SLPM" |

The label "FLOX =" indicates which channel is being displayed. The flow value which follows is a direct readout complete with the units of measurement shown.

The display will blink if the reading is within about 5% of full scale. This is a warning that there isn't much "headroom" left for accurate readings.

## 3.3 Flow Setpoint Display and Adjustment (Controllers Only)

Flo-Box toggles between flow reading and flow setpoint by momentarily depressing the push button labeled "READ/SET". When in the READ mode the display is showing flow value as above. When in the SET mode, the display shows the current setpoint value as shown below:

| SETPOINT VALUE | "SET1 = 100 SLPM" |
|---|---|
| | "SET2 = 225 SCCM" |
| | "SET3 = 25.0 CFM" |
| | "SET4 = 10.5 SLPM" |

The label "SETX = " indicates which channel the setpoint is for. The setpoint value which follows is a direct readout in the units of measurement for that particular range.

NOTE: If left in the setpoint read mode, after a short time the display reverts to reading flow value. This avoids mistakenly reading the setpoint for the flow value.

## 3.4 High/Low Alarms Display and Adjustment

For each channel, there is a high alarm and low alarm provided. Each alarm output is active whenever the flow is above or below a preset value, respectively. All alarm outputs are OPEN COLLECTOR NPN and sink current to COMMON. If driving a relay a protection diode must be connected across the coil. See Appendix A for electrical ratings.

The alarm adjustments are located internally. The front bezel must first be removed by unscrewing the four black screws holding it in place then sliding the top cover out to expose the main PCB.

The alarm display is activated by depressing internal push buttons. These buttons are color-coded and located near the rear panel on the same side of the box as the AC power connector.

Depress the light grey push button to display the low alarm setting. While this button is depressed, the low alarm setpoint for the currently selected channel is displayed on the LCD. An example is shown below:

LAL1 20.0 SCCM

When the flow value is less than the alarm value, the low alarm is active. (Alarm is ON).

The blue push button displays the high alarm setpoint in the same way.

The alarm adjustment pots are located near the front panel behind the front push buttons. The silkscreen legend identifies each pot.

## 3.5 Totalize (Mass Flow Integration) Function

The totalize option records the total mass flow for each channel. This funciton is battery backed-up and so is highly immune to power line interruptions. The display of total mass is in engineering units consistent with flow units.

### 3.5.1 Total Mass Flow Display

To display total mass flow, momentarily depress the front panel lbutton labeled "TOTALIZE". This will cause the display to show total flow as below:

T1 001215 CC

The label "T1 =" shows that channel 1 total mass flow is being displayed. If the button is held for a few moments the elapsed time since totalization began will be shown. This is in the format:

TIME 9999.99 HRS

### 3.5.2 Reset of Totalize Function

If the TOTALIZE push button is held while the elapsed time is being shown the display will change to:

READY TO RESETX

where X is the current channel. When this display is visible, and while continuing to hold the TOTALIZE push button, the CHANNEL SELECT push button is activated, the totalizer and elapsed time indication for that channel are both set to all zeroes.

# 4 REAR PANEL CONNECTIONS

## 4.1 Power Line and Fuse

The AC power line connector is on the back panel. A cordset is supplied with Flo-Box compatible wall outlets in your country.

The fuse is an integral part of the AC power connector. To remove the fuse, first turn the front panel power switch OFF, then remove the cordset front the back panel power connector. With the cordset removed, a small door built into the back panel power connector can now be flipped up exposing the fuse holder. In USA Flo-Boxes there is a single grey fuse holder which can be unclipped and pulled out by hand. The fuse is an AGC type 3 amp rating. These fuses are widely available at practically any hardware store, gas station, etc.

## 4.2 20-Pin Connectors for Flow Meters/Controllers

The back panel has five 20-pin headers labeled Channel 1 through Channel 5. Each channel is set-up for specific transducer. Be sure that the serial number on the side of the transducer agrees with the rear panel label. Normally, cables are pre-wired and the entire system is carefully set-up at the factory. If you need to know pin assignments, refer to Appendix B.

**CAUTION: DO NOT PLUG A TRANSDUCER INTO THE WRONG CHANNEL AS FLOW VALUES WILL BE EXTREMELY INACCURATE AND/OR DAMAGE MAY RESULT TO FLO-BOX AND TRANSDUCER.**

## 4.3 50-Pin I/O Connector

The 50-pin I/O connector on the back panel is the means to access many of Flo-Boxes functions such as linear flow outputs, valve override and monitoring, etc. The following section covers these functions in detail. Refer to Appendix B for pin assignments.

### 4.3.1 Flow Value Output 0-5 VDC and 4-20 mA

The 50-pin I/O connector contains two analog outputs for each channel. One supplies a 0-5 VDC LINEAR analog of the flow value referred to common. The other supplies a 4-20 mA. LINEAR analog of the flow value referred to +15 VDC. Both outputs are always present for all channels. Refer to Appendix B for pin assignments.

### 4.3.2 Valve Off/Purge/ Monitor (Side-Trak Controllers Only)

The 50-pin I/O connector has connections for Side-Trak controller systems to drive the valve fully closed or fully open. Also, the voltage across the valve may be monitored to help determine when maintenance is required.

If the valve off pin for a channel is driven to common, the valve is closed regardless of setpoint. This pin is TTL compatible. Refer to Appendix B for pin assignments.

The valve purge function is activated by the VALVE TP (test point) pin. When this pin is driven to common the valve is fully open regardless of setpoint. This pin must source current when driven to common. If a volt meter is connected from this pin to –15 VDC, the voltage across the valve coil may be read. Over time, this voltage

may increase, possibly indicating the need for maintenance of the flow path. Refer to Appendix B for pin assignments.

### 4.3.3 High/Low Flow Alarm Outputs

The 50-pin connector has two alarm outputs per channel. One is active when the f low drops below a preset value (low alarm). The other is active when the flow increases above a preset value (high alarm). All alarm outputs are open collector. Maximum current is 100 mA per alarm. Maximum voltage is 30 VDC. If a relay is being driven by an alarm a diode must be connected across the relay coil with reverse polarity.

A high and low alarm may be connected in parallel to make a window alarm. Whenever the flow is inside of the window defined by the two alarms, the alarm is inactive. If the flow is outside of the window the alarm is active.

### 4.4 Automatic/Manual Setpoint Selection (Controllers)

There are five plastic programming jumpers plugged into a header on the back panel. For each channel they determine whether the setpoint voltage (0-5 VDC) comes from the front panel pots (MANUAL) or from the 50-pin I/O connector (AUTOMATIC). These jumpers are easily changed in the field simply by unplugging them and moving them to the other positon. Refer to Appendix B for I/O connector assignments.

# 5 MAINTENANCE

Normally each Flo-Box is carefully set-up at Sierra and needs no maintenance. Individual transducers may need periodic flow path maintenance. Refer to transducer manuals for the proper procedure.

Most transducer instruction manuals also have procedures for field calibration. It is recommended that field calibration NOT be done unless you are absolutely certain you possess the proper laboratory equipment. Refer to transducer manuals for the proper procedure.

## 5.1 Factory Service

Before returning any equipment to the factory, you must request and complete a Sierra Calibration/Repair Data Sheet. To obtain the data sheet contact Customer Service at:

(800) 866-0200 or (831) 373-0200 in the USA
or +31(0)20-6145810 in Europe.

Return shipments to:

USA Headquarters
Sierra Instruments Service Department
5 Harris Court, Building W
Monterey, CA 93940

European Headquarters
Sierra Instruments b.v. Service Department
Bolstoen 30A
1046 AV Amsterdam, The Netherlands

# APPENDIX A

## Specifications

GENERAL
Flo-Box Powers/Reads up to five transducers.
Flow, Setpoint, High Alarm, and Low Alarm directly displayed in engineering units.
Linearizes and outputs 0-5 volts and 4-20 mA for each channel.
Valve control functions of Close/Purge/Monitor.
Built-in ten turn precision setpoint pots.
Totalizes (optional) mass flow in engineering units and displays elapsed time in decimal hours.

INPUT POWER
115 VAC plus or minus 10%
230 VAC plus or minus 10% (optional)

OUTPUT POWER
+15 VDC @ 1.25 A
–15 VDC @ .90 A

OUTPUT HUM AND NOISE
Less than .05 Volts RMS

AMBIENT TEMPERATURE RANGE
At full rated power: 0 to 45 degrees C.
At half rated power: 0 to 60 degrees C.

RELATIVE HUMIDITY
0 to 50% non-condensing

DISPLAY
16 character alpha-numeric
All channels read directly in engineering units

CONTROLS
Three front panel push buttons Channel Select, Set/Read, and Totalize.
Channel Select advances channel being displayed in 1-2-3-4-5-1 sequence.
Set/Read toggles display between flow value and setpoint value.
Totalize (optional) shows total mass flow and elapsed time.
Five precision ten turn setpoint pots (controllers).

INPUTS
0-5 VDC and 4-20 mA. for each channel (Jumper selected)
Auto/Manual Setpoint (Controllers) Jumper selected from back panel.
Valve Off (Side-Trak Controllers) TTL compatible.

OUTPUTS
0-5 VDC and 4-20 m A. LINEAR for each channel.
0-5 VDC is referred to common.
4-20 mA is referred to +15 VDC.
Low Alarm and High Alarm open collector output for each channel. Able to sink 100 mA to common. Stand-off voltage 30 VDC. Independently set by internal push buttons/pots. Uses front panel display to show alarm points directly in engineering units.

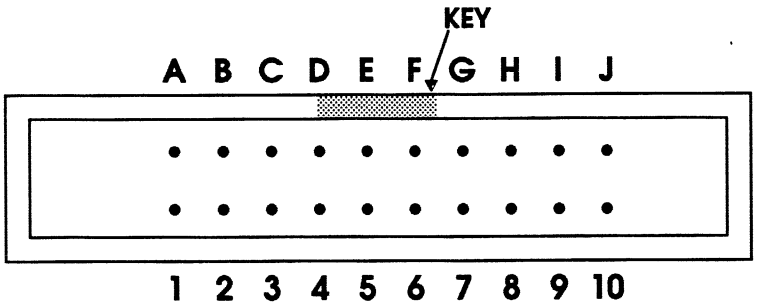
TOTALIZER
Up to five Channels totalized with crystal time base accuracy.
Totalizer has 6-digit capacity accumulated directly in the appropriate engineering units.
Totalizer has 6-digit elapsed time meter with 9999.99 hour format.
Data is battery protected for two days in the event of power failure.
Battery automatically recharges on resumption of power.

DIMENSIONS
3" high x 11" wide x 11" deep (without mounting ears)

WEIGHT
7 lbs.

# APPENDIX B

## Back Panel Connector Pin Assignments; 20-Pin Transducer Connector

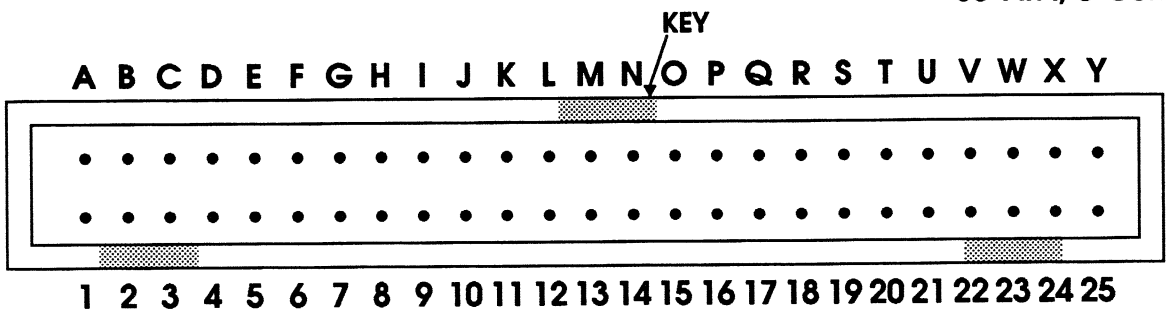



(View of connector from back of enclosure)

| PIN NO. | FUNCTION |
|---|---|
| A | Setpoint Output to Controllers |
| B | Common |
| C | Common |
| D | Valve Test Point (Avail. I/O Connector) |
| E | RED Connection (Factory use only) |
| F | –15 VDC supply from System Unit to Transducers |
| G | No Connection |
| H | High Alarm Output (Avail. I/O Connector) |
| I | Low Alarm Output (Avail. I/O Connector) |
| J | Valve Off (Avail. I/O Connector) |
| 1 | Chassis Ground |
| 2 | Common |
| 3 | 0-5 Volt Signal from Transducer |
| 4 | +15 VDC Supply from Flo-Box to Transducers |
| 5 | BLACK Connection (Factory use only) |
| 6 | No Connection |
| 7 | No Connection |
| 8 | +15 VDC Supply from Flo-Box to Transducers |
| 9 | 4-20 mA Signal from Transducer |
| 10 | Common |

# APPENDIX C

**Top View**
**50-Pin I/O Connector**




(View of connector from back of enclosure)

| PIN NO. | FUNCTION |
|---|---|
| A | Channel 1 0-5 Volt Linear Output |
| B | Channel 2 0-5 Volt Linear Output |
| C | Channel 3 0-5 Volt Linear Output |
| D | Channel 4 0-5 Volt Linear Output |
| E | Channel 5 0-5 Volt Linear Output |
| F | Channel 1 Automatic Setpoint Input |
| G | Channel 2 Automatic Setpoint Input |
| H | Channel 3 Automatic Setpoint Input |
| I | Channel 4 Automatic Setpoint Input |
| J | Channel 5 Automatic Setpoint Input |
| K | Channel 1 4-20 mA Linear Output |
| L | Channel 2 4-20 mA Linear Output |
| M | Channel 3 4-20 mA Linear Output |
| N | Channel 4 4-20 mA Linear Output |
| O | Channel 5 4-20 mA Linear Output |
| P | +15 VDC Power Supply |
| Q | +15 VDC Power Supply |
| R | Common |
| S | Common |
| T | Channel 1 High Alarm Output (Open Collector) |
| U | Channel 2 High Alarm Output |
| V | Channel 3 High Alarm Output |
| W | Channel 4 High Alarm Output |
| X | Channel 5 High Alarm Output |
| Y | Future Expansion |
| 1 | Common |
| 2 | Common |
| 3 | Common |
| 4 | Common |
| 5 | Common |
| 6 | Channel 1 Valve Test Point |
| 7 | Channel 2 Valve Test Point |

| | |
|---|---|
| 8 | Channel 3 Valve Test Point |
| 9 | Channel 4 Valve Test Point |
| 10 | Channel 5 Valve Test Point |
| 11 | –15 Power Supply |
| 12 | –15 Power Supply |
| 13 | Channel 1 Valve Off Input |
| 14 | Channel 2 Valve Off Input |
| 15 | Channel 3 Valve Off Input |
| 16 | Channel 4 Valve Off Input |
| 17 | Channel 5 Valve Off Input |
| 18 | Common |
| 19 | Common |
| 20 | Channel 1 Low Alarm Output |
| 21 | Channel 2 Low Alarm Output |
| 22 | Channel 3 Low Alarm Output |
| 23 | Channel 4 Low Alarm Output |
| 24 | Channel 5 Low Alarm Output |
| 25 | Future Expansion |

# Ratio Control Option Appendix D

The constant ratio-control option ("-RC" in the model code), provides the user with the ability to set and maintain an exact ratio of gas flow between two (or more) mass flow controllers (MFCs). The control box accomplishes this by scaling the setpoint to the slave controller(s) from the output of the master controller. Thus, even though the ratio can be initially set up without flow, actual operation of the slaves will not occur until a gas flow is established through the master. If the master inadvertently stops flowing (the gas runs out), the slave(s) will close. Thus this feature provides a constant ratio control when gas is flowing correctly, and a safety shut off for the slaves if the master gas runs out.

1. Channel one is typically set up as the master channel and should be cabled to the master controller (see the label on the control box to confirm that channel one matches the range of the master controller)

2. Channel two is typically set up as a slave channel (the channel that you want to follow the master) and should be cabled to the slave controller. If more than one slave is being used, additional channels may be set up at the factory. (It is convenient but not necessary to scale the slave channel(s) in percentage rather than actual engineering units)

3. With the front-panel switch in the "Normal" position, each channel of the box will function independently to supply command signals to the separate controllers. In the "Ratio" position, channel one will be the master and the slave channel(s) will follow the lead of the master, using its output signal to establish a setpoint(s).

4. If the constant-ratio feature is to be activated:

    a. Begin with the front panel switch in the "Normal" position. (Flow is not needed at this point though it can be done with or without it – the controllers don't even need to be connected to the cables)

    b. Switch the channel dial to channel two (the slave channel). Calculate the percentage at which you want this slave controller to follow the master. With the Set/Read switch in the set position, dial in the flow that corresponds to this percentage.

    Example #1: The master is scaled for a flow of 0-350, and the slave is also scaled for 0-350. You desire to have the slave follow the master at a 100% flow ratio. In "Normal" mode, switch the Set/Read to "Set" and dial in a setpoint of 350 to channel two (it makes no difference what channel one is doing at this point). Since the two controllers are scaled the same, they will always flow the same rate.

    Example #2: If you desire channel two to follow the master at a ratio of 30%, set channel two to 105 (30% of it's full scale range).

    Example #3: The master is scaled for a flow of 0-350, and channel two scaled for percentage (0-100). If you desire channel two to follow the master at 65% of the slave's capacity, set channel two to 65.

    Example #4: Master channel scaled for 0-350, slave scaled for 0-200. You want the slave to follow at 40% of its own capacity. In "Normal" mode, set channel two to 0.4 X 200, or 80. Now, when the master is flowing 350, the slave will flow 80, and when the master is reduced to a flow of 175, the slave will reduce to a flow of 40.

    c. Switch the Normal/Ratio switch to "Ratio". Now, your ratio feature is scaled and the box is ready to use for a constant ratio application.

d. Turn off the power switch on the front of the box, attach the cables and the controllers (if you haven't already done so), and turn the power on.

e. Apply gas pressure to the inlet of the controllers per the operating pressure listed on the labels.

f. Box settings: Set/Read to "Set", Normal/Ratio to "Ratio", Channel knob to "Channel 1" (the master channel), and the jumpers (on the back of the box) in the "Manual" position.

g. Dial in the desired flow to control the master controller. The slave(s) will follow at the pre-set ratio. To see the flows, switch the Set/Read switch to "Read" and monitor channel one and channel two, confirming that the slave is following the master at the pre-set ratio.