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Digital Flo-Box™
Model 951



Instruction Manual

IM-951, Rev. B.1
December 2010

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DESCRIPTION

The Model 951 Digital Flow Box is a microprocessor-based digital indicator and power supply, capable of interfacing directly to a mass flow meter or a mass flow controller. The integrated +/-15 vdc @250ma power supply provides a well regulated, short circuit and thermal overload protected output. It is packaged in a small 1/8 DIN, 5.5" deep extruded aluminum housing which provides excellent EMI/RFI shielding and good heat dissipation characteristics.

The Model 951 is a state-of-the-art product and uses the latest surface mount components. The internal microprocessor provides the following capabilites.

Pushbutton Zero and Full Scale Calibration
Front Panel Setup of Flow Controller Setpoint Voltage (0-5 vdc)
Front Panel Setup of (2) High and (2) Low Digital Alarms with open collector outputs.

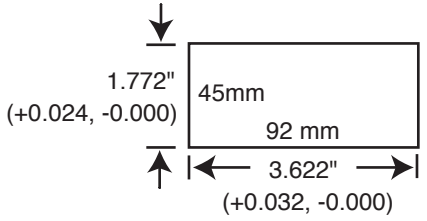
SPECIFICATIONS

Signal Input:	0-5 vdc
Input Resistance:	> 1 Megohm
Input Bias Current:	< 1 na
Display Type:	0.4" high efficiency red LED's
Max display range:	+/- 99,999 counts
A/D Resolution:	+/- 19,999 counts
Linearity:	+/- 0.01% FS +/- 1 count
FS Accuracy:	+/-0.01% FS +/- 1 count
FS Step Response:	500ms (typ)
Overrange Display:	Flashing digits for input > 5.5 vdc
No Sensor Indication:	Flashing digits
Flowmeter Setpoint Output:	0-5 vdc
Flowmeter Power Supply:	+/- 15 vdc +/- 5% @ 400 mA (max)
	+/- 15 vdc +/- 5% @ 250 mA (min)
Operating range:	-10 to +50 degC
Input Power:	100, 110 and 240 VAC
	(solder pad jumper selectable)
Pkg dimensions:	3.78W x 1.89H x 5.13D

INSTALLATION AND WIRING

INSTALLATION

The Model 951 enclosure is designated for panel mounting in a 1/8 DIN cutout. The cutout dimensions are shown below.



To panel mount the 951, perform the following steps:

1. Rotate the four pawl screws (outside screws in each corner) several turns counter-clockwise to retract the pawls. Make sure the pawls retract enough to clear the back of the mounting panel. The pawls may be retracted to accomodate panel thicknesses up to 0.25 inches (6.35mm).

2. Insert the instrument into the panel cutout.

3. Position the pawls so that their elongated dimension overlaps the panel cutout, then tighten the screws. Do not over-tighten.

4. Installation complete.

WIRING

Reference Figures 3 and 4 for TRANSDUCER and INPUT/OUTPUT (I/O) wiring information. Power is applied with a 3-prong AC power cord (Europlug). The instrument is protected by a 250V, 500ma, slo blo, 5mm fuse. The fuse holder is an integral part of the input power connector. A spare fuse is provided in the fuse holder. Internal solder jumpers are provided to allow 100, 110 or 240VAC operation.

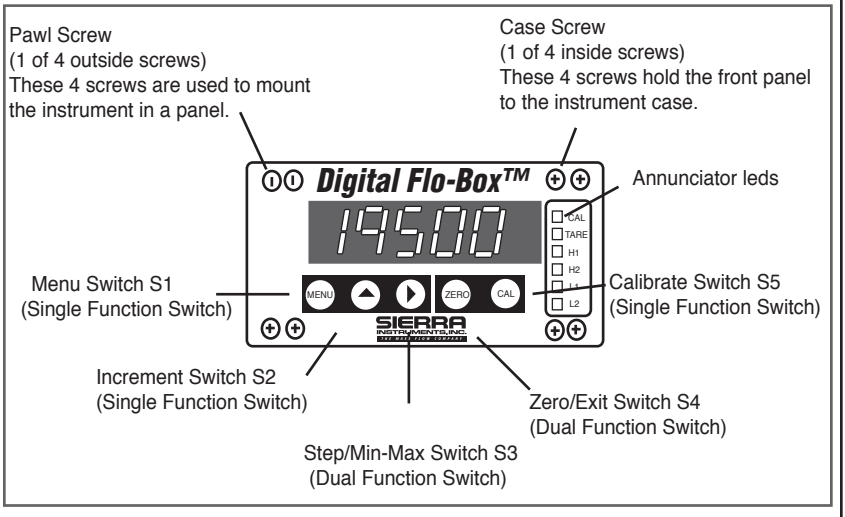


Figure 1. Model 951 Front Panel View

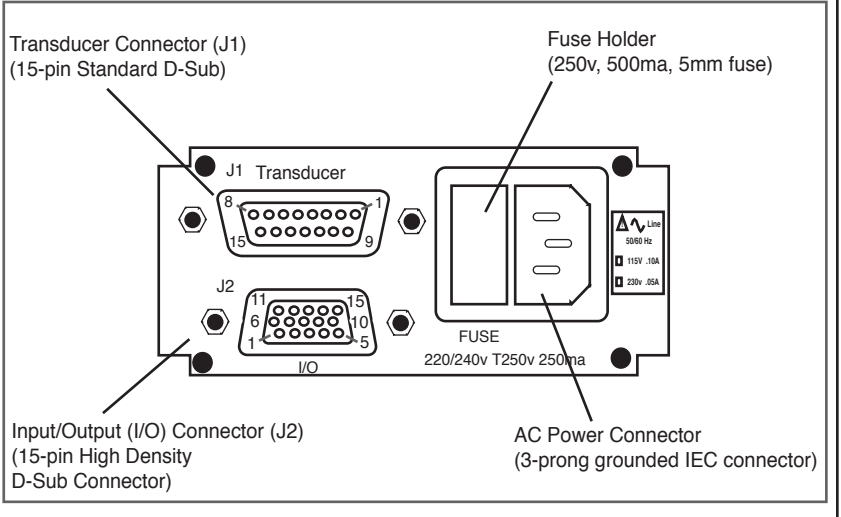


Figure 2. Model 951 Rear Panel View

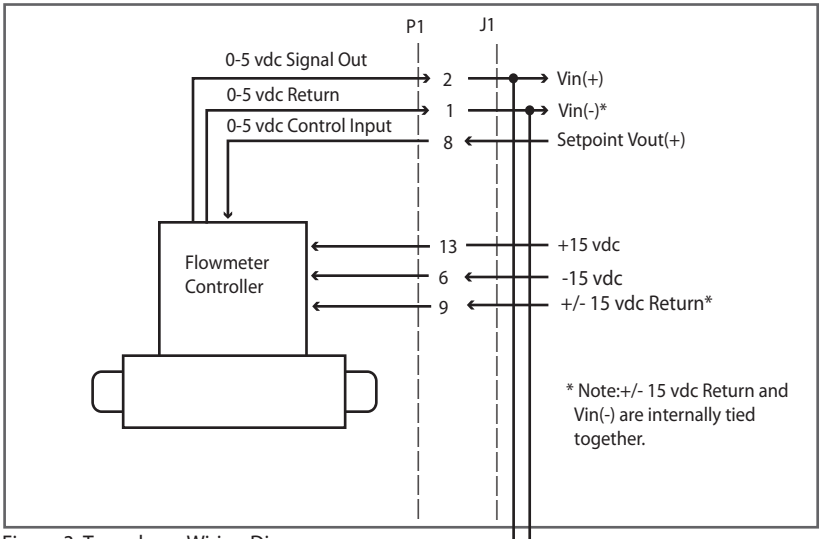


Figure 3. Transducer Wiring Diagram

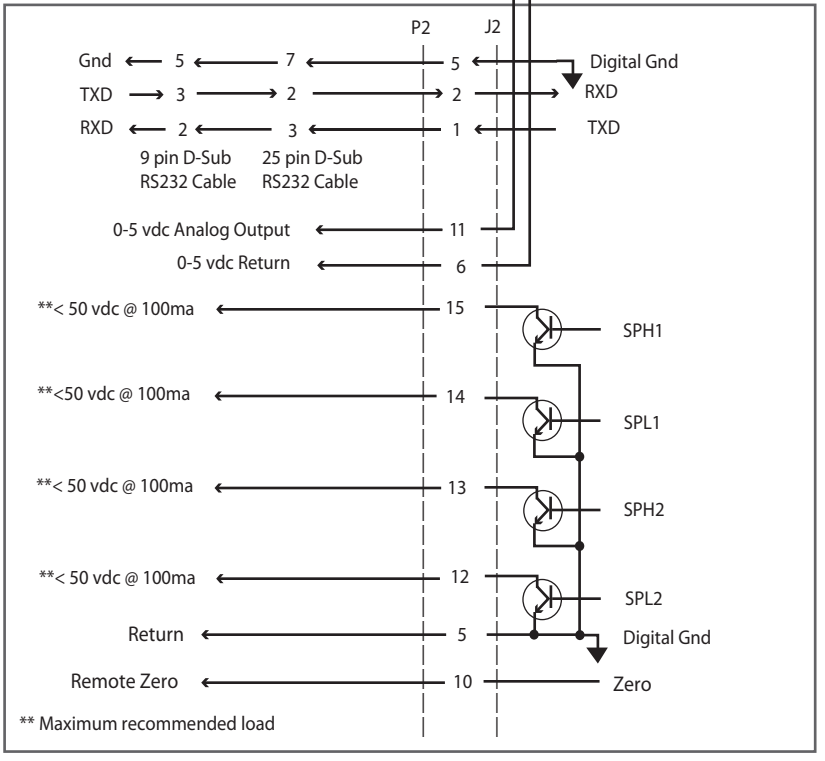
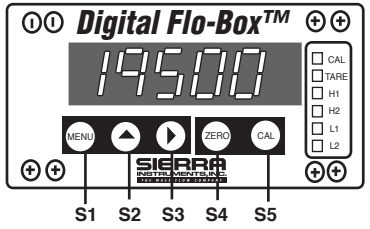


Figure 4. Input/Output Wiring Diagram

SWITCH AND FUNCTION DEFINITIONS

SWITCH DEFINITIONS



Menu Switch (S1)

The Menu switch (S1) is used to cycle through the flow controller setpoints, alarm setpoints, alarm hysteresis, calibration values and decimal point locations.
The sequence is as follows. The designators, in parenthesis, identify text that will be displayed, momentarily, followed by the value.

Setpoint for Flow	(StPt)
Alarm Set Point High 1	(SPH1)
Alarm Set Point Low 1	(SPL1)
Alarm Set Point High 2	(SPH2)
Alarm Set Point Low 2	(SPL2)
Hysteresis High	(HH)
Hysteresis Low	(HL)
Cal	(CAL)
Decimal Point	(dP)
Exit	

While in the Mode Selection sequence, the indicator is no longer monitoring the input signal. To exit at any time, simply depress S4. All new data entered prior to exiting, except StPt, will be stored in non-volatile memory and recalled at power on. The StPt value is retained in static RAM and valid only while power to the unit is maintained. At power turn on the value of StPt defaults to 0000 for safety and the Setpoint output voltage will be approximately -0.5 vdc.

Increment Switch (S2)
This switch increments the flashing digit. When first used, no digits may be flashing. The most significant digit for StPt can be turned off using S2. While updating this digit the display will toggle through the following digits: 1, 2, 3, 4, 5, 6, 7, 8, 9, Blank. Zero (0) can not be selected.

SWITCH DEFINITIONS (cont)

Step and Min-Max Switch (S3)

This switch has a dual function. When in the MENU sequence, it steps the digit to be incremented, one position to the right. Using S3 in conjunction with S2 allows rapid updating of all parameter values.

When not in the MENU sequence, depressing S3 momentarily displays the maximum and minimum flow readings diplayed since power was applied. These values are stored in static RAMS and are reset when power is applied.

Zero and Exit Switch (S4)

This switch has a dual function. When not in the MENU sequence, this switch must be depressed and held for approximately 3 seconds before it zeroes the reading on the display. The ZERO annunciator on the front panel should be illuminated. ZEROing is accomplished by storing the reading just prior to ZEROing. This value is retained in non-volatile memory and recalled when power is applied. It is also used to compensate the StPt control voltage output.

When in the MENU sequence, this switch is used to exit. All values entered prior to exiting, except for the StPt value, will be retained in non-volatile memory and recalled when power is applied.

Cal Switch (S5)

This switch must be depressed and held for approximately 3 seconds to auto-calibrate the readout. When initially held and depressed for 3 seconds the CAL annunciator will extinquish and the display will read the raw data generated by the analog-to-digital converter. When depressed and held again for 3 seconds the CAL annunciator will illuminate and the raw data will automatically be scaled to the CAL value entered previously. (Reference the PROGRAM INSTRUCTIONS page 10 and the CALIBRATION INSTRUCTIONS on page 13 for more information)

FUNCTION DEFINITIONS

The Mode switch (S1) cycles through the following functions.

Flow Set Point (StPt)

The Setpoint (0-5 vdc) command signal used to control the flow through a flow controller. The output voltage is 0-5 vdc. The setpoint

output is defined as:

Setpoint Output = StPt / CAL x 5.000 vdc +/- Voffset (Zero value)

Example: If the CAL value was programmed to be 7500 sccm and the desired flow rate is 5000 sccm, enter 5000 for the StPt value. Depress the ZERO switch to exit the MODE sequence and the Setpoint Output voltage will be 3.333 vdc. This is assuming the Flowmeter output had no offset voltage.

Alarm Set Point High 1 (SPH1)

SPH1 is a digital setpoint being constantly compared with the displayed reading. If the magnitude and sign of the reading exceeds the SPH1 value, the SPH1 open collector output will activate and pull its respective D-Sub connector pin to ground (Ref Figure 4 on page 4). The front panel LED (H1) will also illuminate. If SPH1 is exceeded, the reading must then drop below SPH1 less the Hysteresis High (HH) value before the open collector output opens and the H1 LED turns off.

Alarm Set Point Low 1 (SPL1)

SPL1 is another digital setpoint being constantly compared with the displayed reading. If the magnitude and sign of the displayed reading is less than the SPL1 value, the SPL1 open collector output will activate and LED (L1) will illuminate. If the displayed reading drops below SPL1, it must then exceed SPL1 plus the Hysteresis Low (HL) value before the open collector output opens and the L1 LED turns off.

FUNCTION DEFINITIONS (cont)

Alarm Set Point High 2 (SPH2)

SPH2 is independent and functions identically to SPH1. SPH2 has its own open collector outputs and front panel LED (H2).

Alarm Set Point Low 2 (SPL2)

SPL2 is independent and functions identically to SPL1. SPL2 has its own open collector outputs and front panel LED (L2).

Alarm Hysteresis High (HH)

HH is the hysteresis value for the alarms SPH1 and SPH2. The hysteresis value determines the number of counts the displayed reading must fall below SPH1 and SPH2 values before deactivating their respective open collector outputs and LEDs. The maximum value of hysteresis is 99 counts while the minimum is 00 counts.

Alarm Hysteresis Low (HL)

HL is the hysteresis value for the alarms SPL1 and SPL2. The hysteresis value determines the number of counts the displayed reading must exceed the SPL1 and SPL2 values before deactivating their respective open collector outputs and LEDs. The maximum value of hysteresis is 99 counts while the minimum is 00 counts.

FS Cal (CAL)

This input allows the user to calibrate the full scale readout to any desired engineering units. This input must be entered prior to performing the calibration. The FS Cal number may be any number from 1 to 99,999. Zero is an invalid FS Cal number. For best resolution and stability, choose a CAL number between 2000 and 19000 counts.

Example: If the Flowmeter is to be calibrated at a full scale flowrate of 500 sccm, the FS Cal value could be 500.00, 500.0 or 500. If the FS Cal value of 500.00 is used, the unit will automatically count by 3 when full scale calibration is completed since the analog-to-digital converter resolution is only 19,999 counts. Choosing a FS Cal value of 500.0 or 500 assures the best resolution and stability in this particular case.

Decimal Point (dP)

dP allows selection of decimal point locations for display. The locations selectable are x.xxxx, xx.xxx, xxx.xx, xxxx.x and xxxxx.

OPERATING INSTRUCTIONS

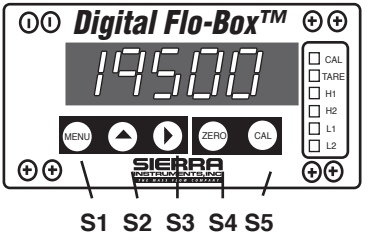
TURN-ON INSTRUCTIONS

Reference Figures 3 and 4 for proper input and output signal wiring.

1. Apply power to the instrument.
2. Verify the instrument readout blanks momentarily, then displays the value of the input signal. If the display blinks continuously it is because the Model 951 is not receiving a signal. Check wiring.
3. If your Model 951 was calibrated at the factory, you're ready to go. If it was not factory calibrated see page 13..

PROGRAM INSTRUCTIONS (Refer to program menu diagram on page 17)

Five front panel switches (S1, S2, S3, S4 and S5) allow the user to program Flow Controller Setpoint Output Voltage (StPt), Digital Alarm Setpoints (SPH1, SPL1, SPH2 and SPL2), Alarm Hysteresis (HH and HL), Calibration Value (CAL) and Decimal Points (dP) and monitor minimum, maximum or real time values.



1. Depress MENU (S1) switch once.

   The text StPt will be displayed momentarily followed by the current value for the Flow Controller Setpoint. Use switches S2 and S3 to set the StPt value. Proceed to Step 2 to set Alarm Set Point H1 (SPH1) or depress S4 to exit the MENU sequence. If S4 is depressed the latest StPt value is used to generate a new Flow Controller Setpoint output voltage.

PROGRAM INSTRUCTIONS (cont)

2. Depress MENU (S1) switch once.
   The text SPH1 followed by the current value of Alarm Set Point High 1 (SPH1) will be displayed. Use S2 and S3 to set Alarm Set Point High 1 to the desired value. Proceed to Step 3 to set Alarm Setpoint Low 1 (SPL1) or depress S4 to exit MENU sequence. If S4 is depressed, the new value for SPH1 will be saved in non-volatile NOVRAM memory.

3. Depress MENU (S1) switch once.

   The text SPL1 followed by the current value of Alarm Set Point Low 1 will be displayed. Repeat Step 2 to set Alarm Set Point Low 1 to the desired value. Proceed to Step 4 or depress S4 to exit.

4. Depress MENU (S1) switch once.
   The text SPH2 followed by the current value of Alarm Set Point High 2 will be displayed. Repeat Step 2 to set Alarm Set Point High 2 to the desired value. Proceed to Step 5 or depress S4 to exit.

5. Depress MENU (S1) switch once.

   The text SPL2 followed by the current value of Alarm Set Point Low 2 will be displayed. Repeat Step 2 to set Alarm Set Point Low 2 to the desired value. Proceed to Step 6 or depress S4 to exit.

6. Depress MENU (S1) switch once.

   The text HH followed by the current value of Alarm Hysteresis High will display. Repeat Step 2 to set Hysteresis High to the desired value. The maximum value for HH is 99 counts. Proceed to Step 7 or depress S4 to exit.

PROGRAM INSTRUCTIONS (cont)

7. Depress MENU (S1) switch once.

   The text HL followed by the current value of Hysteresis Low will be displayed. Repeat Step 2 to set Alarm Hysteresis Low to the desired value. The maximum value for HL is 99 counts. Proceed to Step 8 or depress S4 to exit.

8. Depress MENU (S1) switch once.

   The text CAL followed by the current CAL number will be displayed. Use S2 & S3 to set the Cal Number. Remember the Cal Value should be between 2000 & 19000 (decimal not used). Proceed to Step 9 or depress S4 to exit.

9. Depress MENU (S1) switch once.

   The text dP followed by the current decimal position will be shown flashing. Use S2 to set the decimal point to the desired location.

10. Depress MENU (S1) switch once.

    The instrument will exit the MENU Selection Sequence and enter the normal operating mode (i.e. monitoring the input signal) This is the end of the PROGRAM INSTRUCTIONS.

CALIBRATION INSTRUCTIONS

Prior to connecting the 951 to the Flowmeter or Controller, verify that the Controller's +/-15 vdc requirement is no more than 400 ma. The 951 is capable of supplying up to 500ma for short periods of time (in 1/2 or 1 hour increments). Consult the factory if the current requirement is > 350ma for prolonged periods of time.

Connect the 951 to the Flowmeter or Controller or a precision voltage source with an accuracy of 0.01% or better per Figure 3. The voltage source should be connected between J1-1 and J1-2. Apply AC power to the 951. Verify that the 951 lights up and the instrument is displaying a stable reading. If no display appears after 1 or 2 seconds has elapsed, remove the ac power and check the fuse contained in the AC Power Connector at the rear of the 951 (Reference Figure 2 on page 3).

If a stable display appears, allow 10-15 minutes for the 951 to warm up, then perform the calibration procedure shown below. If the display flashes continuously, the 951 is not receiving a flow signal. Check your wiring.

1. The FS Cal (CAL) value must be entered prior to performing this calibration procedure. Reference page 8 to enter the FS Cal (CAL) value.

2. Apply zero flow to the Flowmeter, if calibration is done with a Flowmeter, or zero vdc to the 951, if calibration is done with a precision voltage source.

3. Depress and hold CAL (S5) switch for approximately 3 seconds. Verify FS CAL annunciator is extinquished. The 951 is now uncalibrated.

4. Depress and hold the ZERO (S4) switch for approximately 3 seconds (Reference Figure 1 on page 3). Verify ZERO annunciator LED is illuminated and the display reads 0000 +/- 0001 counts. Ignore the decimal point. The 951 is now zeroed.

5. Apply full scale flow to the Flowmeter or 5.000 vdc +/- 0.0005 vdc to the 951.

CALIBRATION INSTRUCTIONS (cont)

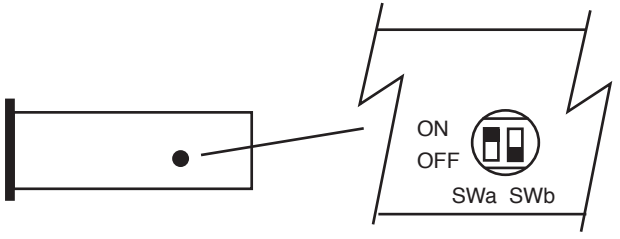
6. Depress and hold CAL (S5) for approximately 3 seconds. The FS CAL LED should illuminate and the readout should display the FS Cal value within +/- 1 digit.

7. The CALIBRATION sequence is now complete.

NOTE: Calibration information (zero and scale factor values) are stored in non-volatile memory and are updated every time calibration step 6 above is performed. ZEROing the display changes and stores a new zero value but does not affect the scale factor value.

RS232 SERIAL COMMUNICATIONS
(Special Order Only)

The Parity (Even or None) and the Baud Rate (2400 or 9600) are selectable by setting DIP switches SWa and SWb, accessible from the right side of the instrument case.



Parity (SWa)	Baud Rate (SWb)
ON = Even	ON = 2400
OFF = None	OFF = 9600

Baud Rate:	Programmable for 2400 or 9600 Baud
Parity:	Programmable for Even or None
Data Bits:	For Even Parity (7 data bits) For Odd Parity (8 data bits)
Stop Bits:	One
Delimeter:	CrLf (Carriage Return-Line Feed)

Command Syntax

Notes: In the following tables, each command or request element separated with square brackets [ ] is for clarity only.

Unless Otherwise Specified

[value] is indicated as % of full scale and takes the following form: signxxx.xx

When entering commands, unless a minus sign is included, value will be accepted as positive.

When responding to a request, value will contain a +/- sign followed by a number complete to two decimal places.
[counts] will represent an actual number within a defined range.

RS232 SERIAL COMMUNICATIONS
(Special Order Only)

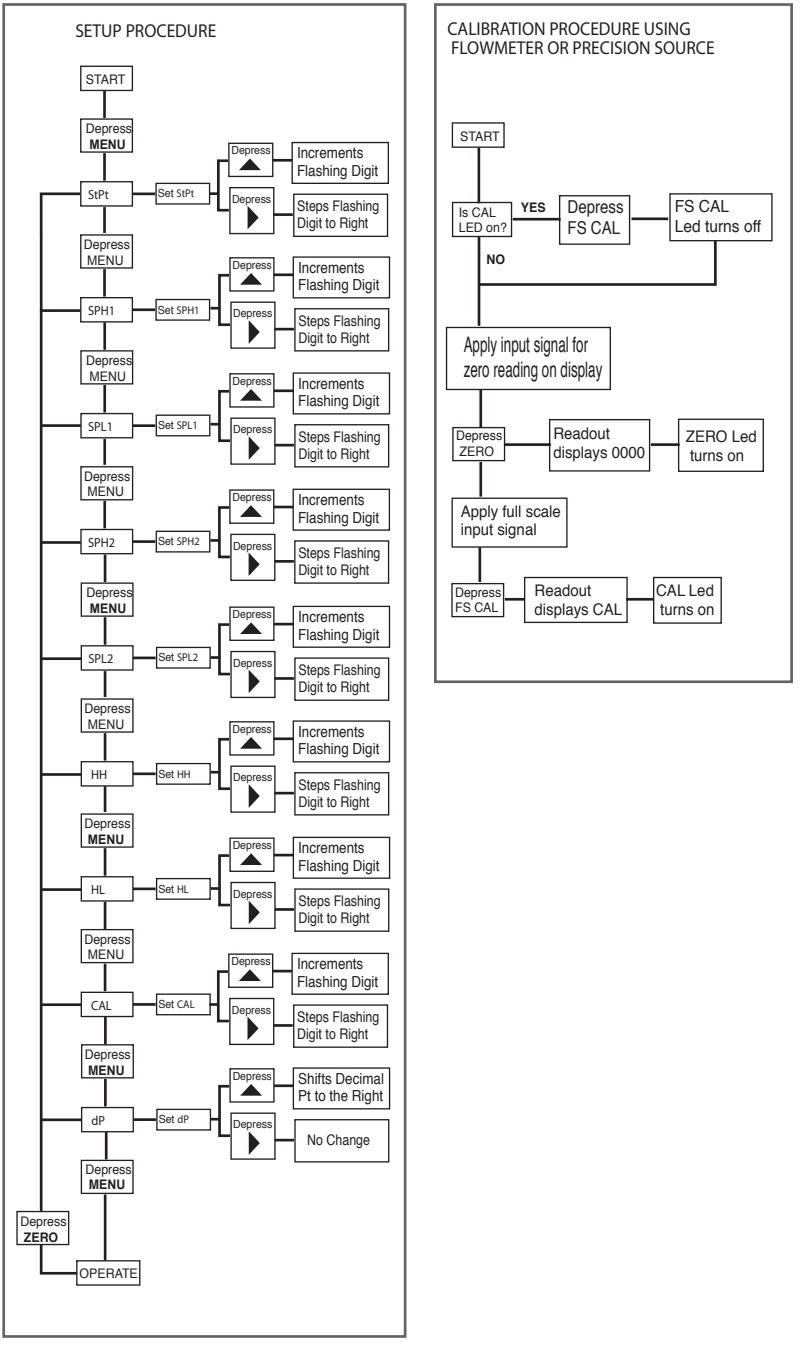
COMMAND PROTOCOL	FUNCTION
[Z] [CR] [LF]	Zero the displayed reading
[F] [CR] [LF]	Calibrate Full Scale (Input signal is scaled to display Full Scale)
[S] [counts] [CR] [LF]	Set Full Scale display value. (counts range = 0 .... 99999)
[D] [value] [CR] [LF]	Set decimal position 1 = x.xxxx 2 = xx.xxx 3 = xxx.xx 4 = xxxx.x 5 = xxxxx
[P1] [value] [CR] [LF]	Set level of Lo Alarm #1
[P2] [value] [CR] [LF]	Set level of Lo Alarm #2
[P3] [value] [CR] [LF]	Set level of Lo Alarm #3
[P4] [value] [CR] [LF]	Set level of Lo Alarm #4
[H1] [counts] [CR] [LF]	Set Lo Alarms #1&2 hysteresis
[H2] [counts] [CR] [LF]	Set Hi Alarms #1&2 hysteresis

REQUEST PROTOCOL	FUNCTION	RETURN MESSAGE
[R5] [CR] [LF]	Pressure value	[P] [value] [CR] [LF]
[R8] [CR] [LF]	Full Scale display	[S] [counts] [CR] [LF]
[R9] [CR] [LF]	Decimal location	[D] [value] [CR] [LF] 1 = x.xxxx 2 = xx.xxx 3 = xxx.xx 4 = xxxx.x 5 = xxxxx
[R1] [CR] [LF]	Lo Alarm #1 level	[P1] [value] [CR] [LF]
[R2] [CR] [LF]	Hi Alarm #1 level	[P2] [value] [CR] [LF]
[R3] [CR] [LF]	Lo Alarm #2 level	[P3] [value] [CR] [LF]
[R4] [CR] [LF]	Hi Alarm #2 level	[P4] [value] [CR] [LF]
[R6] [CR] [LF]	Lo Alarm #1&2 hysteresis	[H1] [counts] [CR] [LF]
[R7] [CR] [LF]	Hi Alarm #1&2 hysteresis	[H2] [counts] [CR] [LF]
[RX] [CR] [LF]	Setpoint value	[X] [counts] [CR] [LF]

SERIAL LOCKOUT:

The Model 951 will respond to RS-232 commands and queries while it is in the normal display mode. When it is in the menu entry or calibration modes it will not respond to RS-232 commands or queries.

MODEL 951 PROGRAM MENU DIAGRAM



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