INSTALLATION & INSTRUCTION MANUAL

SP3000

FLOW COMPUTER

DOC#: MN-3000.DOC

LIQUID CONTROLS SPONSLER, INC.

FLOW MEASURING DEVICES AND CONTROLS

A Unit of the IDEX Corporation

105 Albrecht Drive • Lake Bluff, IL 60044

(847) 295- 1050 • www.sponsler.com

- W A R N I N G -

This instrument contains electronic components that are susceptible to damage by static electricity. Please observe the following handling procedures during the removal, installation, or handling of the internal circuit boards or devices.

HANDLING PROCEDURES

1. Power to unit must be removed.

2. Personnel must be grounded, via wrist strap or other safe, suitable means, before any printed circuit board or other internal device is installed, removed, or adjusted.

3. Printed circuit boards must be transported in a conductive bag or other conductive container. Boards must not be removed from protective enclosure until the immediate time of installation. Removed boards must be placed immediately in protective container for transport, storage, or return to factory.

COMMENTS

This instrument is not unique in its content of EDS (electrostatic discharge) sensitive components. Most modern electrical designs contain components that utilize metal oxide technology (NMOS, CMOS, etc.). Experience has proven that even small amounts of static electricity can damage or destroy these devices. Damaged components, even though they appear to function properly, exhibit early failure.

*** SPONSLER, INC. STRONLY RECOMMENDS THOROUGH UNDERSTANDING AND REVIEW OF THIS MANUAL PRIOR TO INSTALLATION.

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MODEL SP3000 MASS FLOW COMPUTER

INTRODUCTION

1.1 GENERAL DESCRIPTION

The Model SP3000 is a microprocessor based instrument designed to measure and compensate flow in an industrial environment. Three inputs - temperature, pressure, and flow – are provided for calculating the flow at standard conditions. Special signal conditioning circuitry is included to allow direct connection of 2, 3, or 4 wire platinum Resistance Temperature Detectors (RTDs), voltage inputs or current loops. A high speed digital input is provided for interfacing with the meter mounted SP714 Pulse Amplifier. A 32 terminal strip on the rear panel provides easy connection to the instrument.

The Model SP3000 is powered by 50 or 60 Hz, 110 or 220 VAC, switch selectable, or can be ordered for 24 VDC power.

The Model SP3000 is designed to provide continuous, on-line, compensation for true flowrate from volumetric flow transducers. All volumetric, mass, or heat flow calculations are taken with permission from the Flow Measurement Engineering Handbook written by R.W. Miller. Steam (100% quality, saturated, or superheated to 850^{o} F) computations are based on the 1967 ASME Steam tables.

Operator interface is through a 16 key keypad and a 2 line by 20 character liquid crystal display. (The Model SP3000 may also be set up entirely through the optional RS-232 port). Range selection, input filtering characteristics, scaling factors, etc. are selected through the front panel keypad or RS-232 interface. There is no need to disassemble the unit or set any dip switches.

Scaled digital and 4-20mA analog current outputs, that represent compensated flow, are standard for use in remote monitoring of flow. Two form C relays provide isolated flow or temperature/pressure alarm outputs.

There is a single precision voltage reference in the unit used for all analog measurements. A single multi-turn potentiometer is provided for factory calibration. No field adjustments are necessary.

1.2 FEATURES

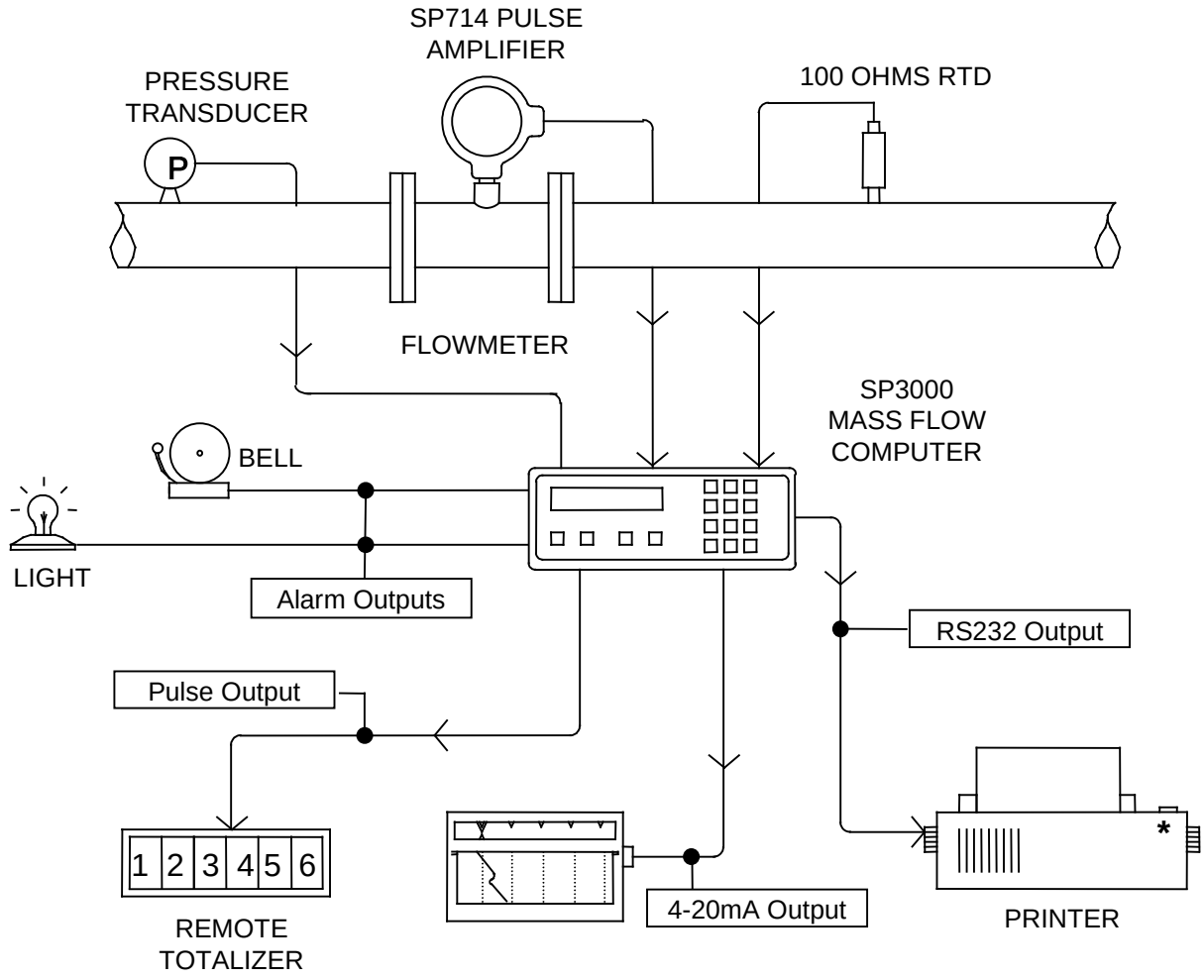
The Model SP3000 is designed to provide accurate and low cost compensated flow measurement for industrial applications. The instrument can be set up to display volumetric, mass, or heat flow, as well as totalized flow, with an overall accuracy of 0.25%.

Fully programmable from the front keypad, the microprocessor-based Model SP3000 Flow Computer provides the operator with prompts to set up the operating parameters of the instrument.

The Flow Computer offers the following features:

* Front Panel 16 key programming keypad
* 2 line 20 character liquid crystal display
* Compensates gas & steam flowrates for temperature and pressure
* Compensates liquid flowrates for temperature
* Direct input of 100 ohms RTD
* Can display flow and heat flowrates and totals
* Scaleable 5V output pulse
* Analog output of 4-20mA proportional to compensated flowrate
* 12 bit input resolution for A/D conversion
* Non-volatile RAM memory
* Self diagnostics of instrument
* Supervisory lockout of keypad
* Provides 24 VDC excitation at 100mA
* English and metric engineering units selectable via front keypad
* Flowrate and temperature/pressure alarms via two SPDT relays
* Real time clock and calendar (not battery backed)
* Optional 16 point linearization of input signal
* Optional RS-232 communications

1.3 APPLICATION



* Pressure Transducer sends 4-20mA signal to Model SP3000
* 100 ohms RTD direct hook-up to Model SP3000
* Meter Mounted SP714 Pulse Amplifier sends digital signal to Model SP3000
* Model SP3000 calculates flow and sends out signals
* 5V pulse out to remote totalizer in supervisory area
* 4-20mA out to stripchart recorder tracks trends
* RS-232 out to printer for data logging
* Alarm relays activate bell and/or light as needed

1.4 GENERAL SPECIFICATIONS

Operating Temperature:	32^o to 122^o F (0^o to 50^o C)
Storage Temperature:	-10^o to 160^o F (-32^o to 71^o C)
Humidity:	0 to 90% Non-Condensing
Front Bezel:	NEMA 4X
Case:	ABS Plastic
Dimensions:	See page 2-1, fig 2-1
Voltage:	115 or 230 VAC +/- 15% (Switch Selectable)
	50/60 Hz, 24 VDC +/- 20%
Power Consumption:	10 Watts max.

1.5 INPUT SPECIFICATIONS

The following applies to all inputs in all modes. Inputs are referenced to the signal ground. All ground terminals are connected internally. The exception is the RTD input which is differential but is referenced to ground.

Transient Protection: 100V 5nsec

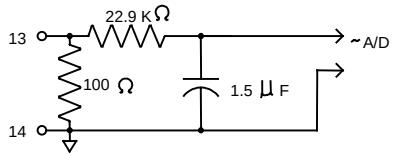
Note: In the event of the specified fault conditions, unit may temporarily malfunction, but no permanent damage will occur.

1.51 ANALOG INPUTS

Temperature, Pressure, and Flow (1 each)

* Current Input

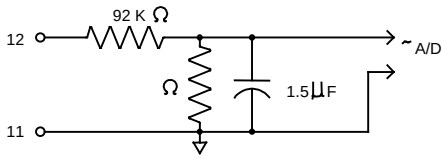
Input Impedance:	100 ohms
Range:	0-20mA, 4-20mA
Maximum sustained input voltage:	5VDC (Fault Condition)



Typical Current Input Schematic:

* Voltage Input

Input Impedance:	100K ohms
Range:	0-5V, 0-10V

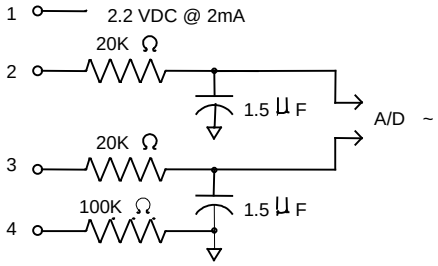


Typical Voltage Input Schematic:

1.52 RTD TEMPERATURE INPUTS

Compatible RTD type: (a=0.00385; DIN 43-760 Calibration)	100 ohms Platinum
Configuration:	2, 3, or 4 wire
Excitation Current:	2mA typical
Max Fault Current:	15mA
Max Voltage on Sense Inputs:	50 VDC
Rejection of 50-60Hz signal: (Automatically based on line frequency)	40 dB (minimum)
Raw Accuracy:	0.2% FS RTI
Temperature Range:	-323.5^{o} to +1378.7^{o} F (-197.5^{o} to +748.1^{o} C)

Typical RTD Schematic:

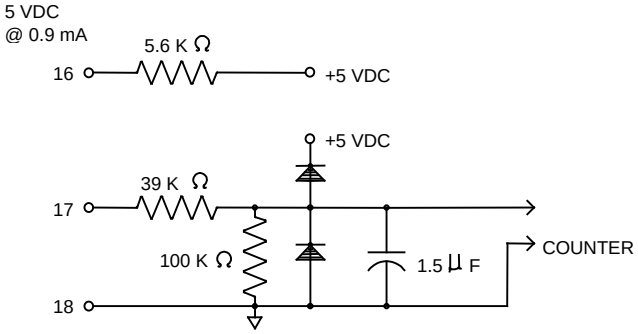


1.53 DIGITAL FLOW INPUT

Range:	3-30 VDC Pulse
Type:	Dry contact, opto-isolated or voltage source
Max Input Frequency:	40kHz
Min. Pulse Width:	10µsec (with 40kHz filter)
Thresholds:	OFF is less than 2.0V/ ON is greater than 2.5V
Input Impedance:	Less than 30K ohms to ground
Excitation Voltage:	5VDC through 5.6K ohms resistor

Min. Frequency to maintain rate display: 1 Hz
Note: Totalizer counts all pulses down to 0 Hz

Typical Digital Pulse Input & Schematic:

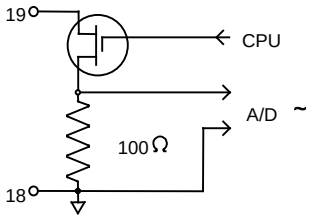


1.6 OUTPUT SPECIFICATIONS

1.61 ANALOG OUTPUT

Number:	1
Range:	4-20mA DC, sink only
Compliance Voltage Range:	3.0-24 VDC
Load Type:	Non-Inductive
Accuracy:	+/- 100 μA
Update Rate:	1 Hz

Analog Output Schematic:

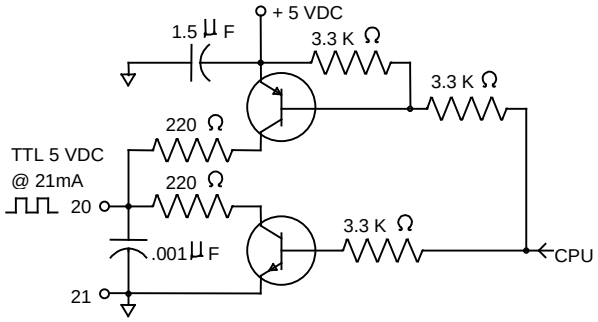


1.62 DIGITAL FLOW PULSE OUTPUT

This output is intended to drive a counter with a minimum input impedance of 1000 ohms. It is also compatible with TTL, LSTTL, and 5V CMOS logic inputs. It is slew rate limited to help prevent RFI.

Number:	1
Output High Voltage No Load:	4.5 Volts min.
4.0mA source:	4.5 Volts min.
Output Low Voltage No Load:	0.2 Volts max.
4.0mA sink:	1.0 Volts max.
Output Waveform:	Symmetric square wave above 1Hz 100msec pulse below 1Hz
Max Output Slew Rate:	27 Volts/μsec
Sustained Fault Voltage for no permanent damage:	7 Volts
Transient Protection:	1500V 50μsec

Pulse Output Schematic:

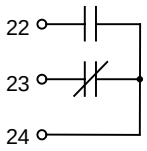


1.63 RELAY OUTPUTS

One relay is provided as a flow alarm and a second is provided for the other alarm conditions. Each has the following specifications:

Type:	Dry contact, Form C
Contact Rating:	10A at 115/230 VAC/28 VDC

Typical Relay Output Schematics:



1.64 AUXILIARY POWER OUTPUT

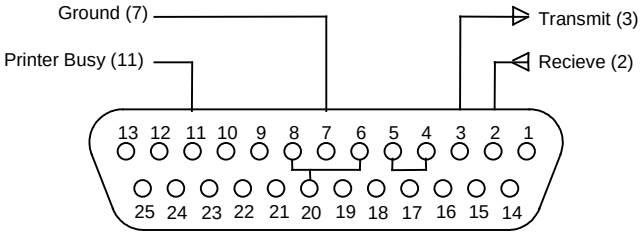
Voltage:	24 VDC regulated and filtered
Isolation:	230 VAC max
Current:	0 to 100 mA
Protection:	Short Circuit Proof

1.7 RS-232 COMMUNICATIONS PORT

(Refer to RS-232 Addendum supplied with RS-232 option)

Connector:	25 Pin Sub-D
Input Impedance:	3000 ohms to 7000 ohms
Compliance Voltage:	
Output:	-25 to –5 (Mark); 5 to 25 (Space); Volts
Input:	-25 to –3 (Mark); 3 to 25 (Space); Volts
Protection:	Short Circuit Proof
Protocol:	8 bits, 1 stop bit
Parity:	None (Not Monitored)
Available Baud Rates:	300, 1200, 9600

RS-232 Connector Pin Out:



Pins 6, 8, and 20 are jumpered together

Pins 4 and 5 are jumpered together

1.8 DATA DISPLAY AND KEYPAD

Internal 2 line by 20 character dot matrix LCD display. Sealed, 16 key panel featuring numeric keys 0-9, plus the following keys:

A	Advance through menus
B	Back up through menus
C	Cancel current menu selection
D	Decimal point key
ENT	General purpose enter or recall data key
CLR	Data clear key

INSTALLATION

2.1 MOUNTING THE INSTRUMENT

The Model SP3000 can be mounted in a user panel greater than 0.047" (1.2mm) and less than 0.187" (4.7mm) thick. Figure 2-1 shows the cutout dimensions, bezel size, and depth needed for the instrument. Be sure to provide additional space for cabling and connections behind the instrument (approximately 1.0"). Additionally, all wiring to the back of the instrument should have sufficient service loops to allow for the easy removal of the instrument from the panel.

Slip the gasket provided over the rear of the instrument case and slide it forward until it engages the inner surface of the front bezel, slide the instrument into the panel opening. Install the screws provided in the mounting brackets and insert in the slots located on all four sides of the instrument. Tighten the screws to firmly secure the bezel and gasket up against the panel.

CAUTION: Do not over tighten mounting screw brackets

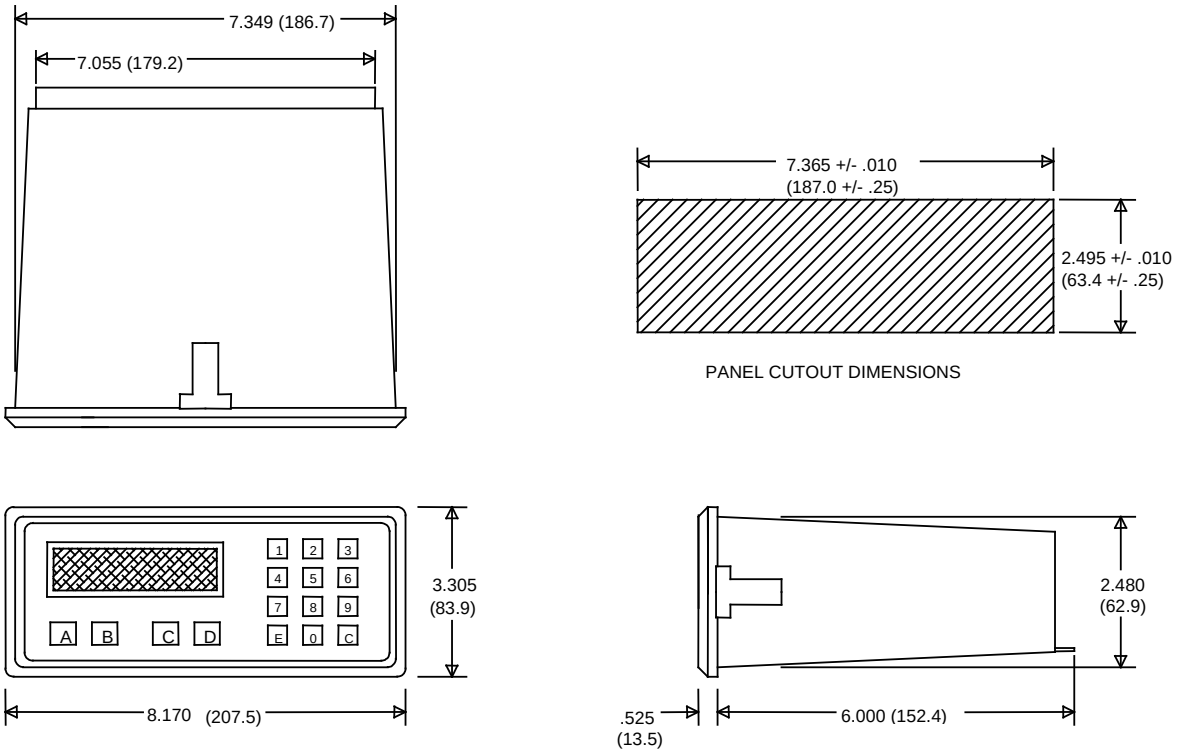


Figure 2-1
Dimensional Layout

2.2 CONNECTING INPUTS AND OUTPUTS

Make sure all power is disconnected before making any electrical connections. All connections are completed at the rear terminal strips as indicated in the external wiring diagram. If cables are in areas with heavy electrical fields, shielding will be required for noise immunity. One end of the shielding should be connected to earth ground. Figures 2-2 though 2-9 show the input, output and power wiring locations for the 32 point terminal block on the back of the instrument.

PIN	RTD	VOLTAGE IN	CURRENT IN	FUNCTION
1	RTD EXCITATION +	----------	----------	
2	RTD SENSE +	----------	----------	
3	RTD SENSE –	----------	----------	CHANNEL 1
4	RTD EXCITATION –	----------	I IN +	TEMPERATURE
5	GROUND (SHIELD)	V IN – (GND)	I IN – (GND)	
6	----------	V IN +	----------	
7	RTD EXCITATION +			
8	RTD SENSE +			
9	RTD SENSE –	----------	----------	CHANNEL 2
10	RTD EXCITATION –	----------	I IN +	PRESSURE OR
11	GROUND (SHIELD)	V IN – (GND)	I IN – (GND)	AUX TEMP
12	----------	V IN +	----------	
13	----------	----------	I IN +	CHANNEL 3
14	GROUND (SHIELD)	V IN – (GND)	I IN – (GND)	FLOW
15	----------	V IN +	----------	ANALOG INPUT
16	EXCITATION VOLTAGE (5.6K Ω PULLUP TO 5 VDC)			CHANNEL 3
17	PULSE INPUT (3-30 VOLTS)			FLOW
18	GROUND (SHIELD)			ANALOG INPUT
19	ANALOG OUTPUT (SINK)			ANALOG OUT 4-20mA
20	PULSE OUTPUT			5 V SCALED
21	GROUND (SHIELD)			PULSE OUTPUT
22	N.O.			
23	N.C.			ALARM RELAY
24	COMMON			
25	N.O.			
26	N.C.			FLOW ALARM
27	COMMON			RELAY
28	115/230 VAC 50/60 HZ			POWER (AC)
29	115/230 VAC 50/60 HZ			
30	+24 VOLTS ISOLATED	Output available	+24 VDC IN	Power input for
31	24 VOLTS RTN	on AC Powered Units	-- DC (GND)	DC Powered Units
32	CHASSIS GROUND			

Figure 2-2
Terminal Designation Label

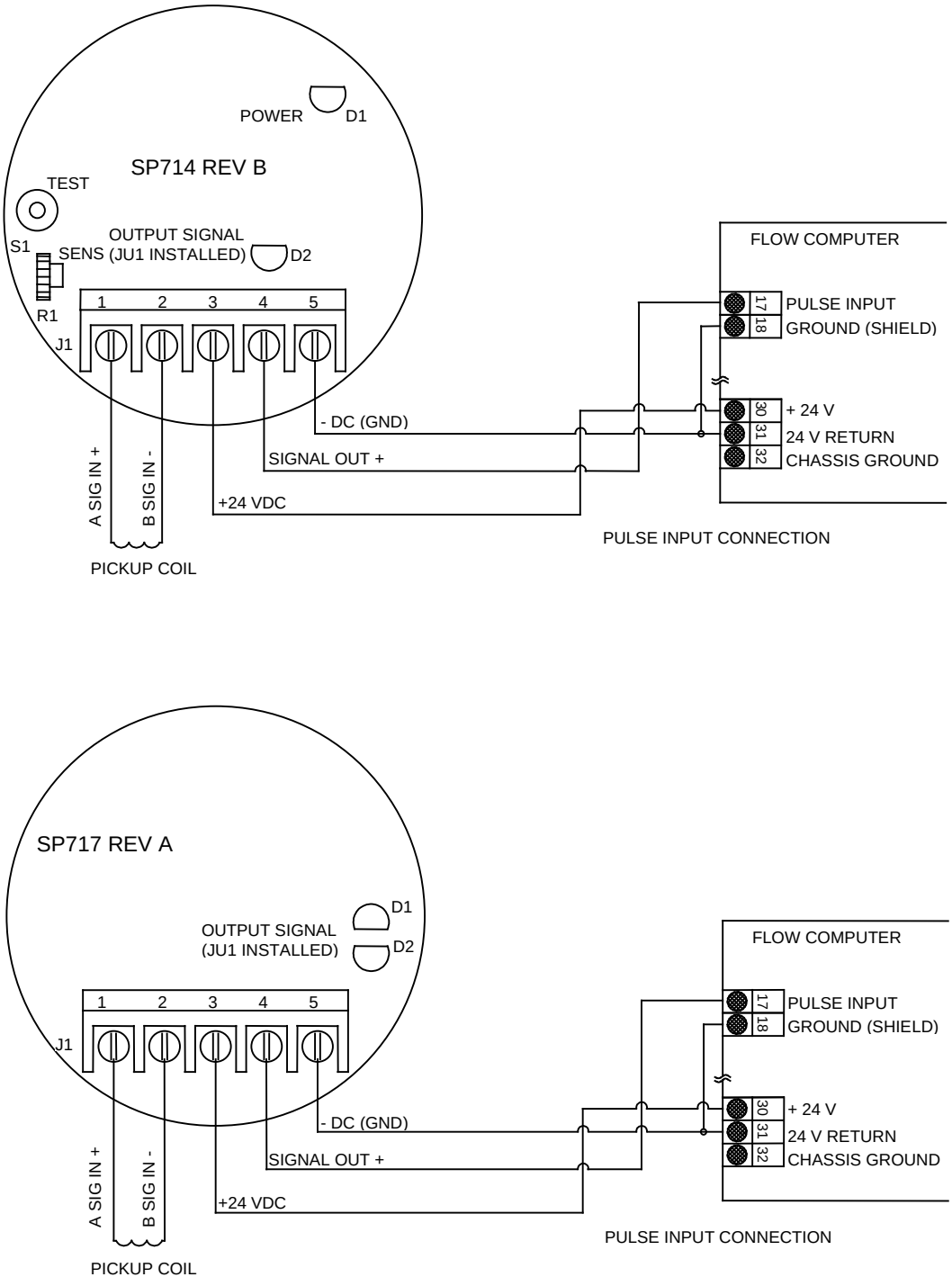
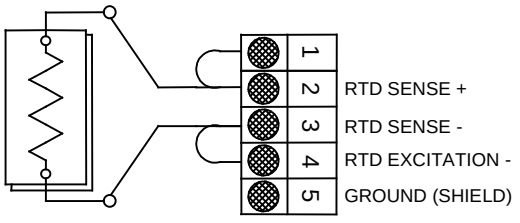
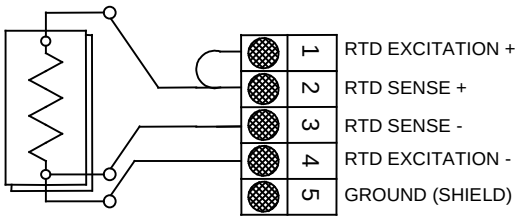


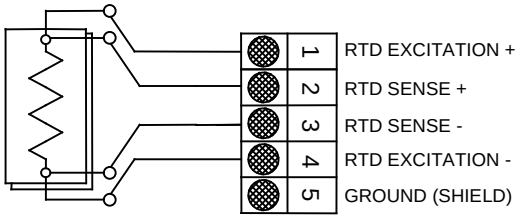
Figure 2-3
SP714 & SP717 Pulse Amplifiers Wiring Diagram



2 WIRE CONNECTION

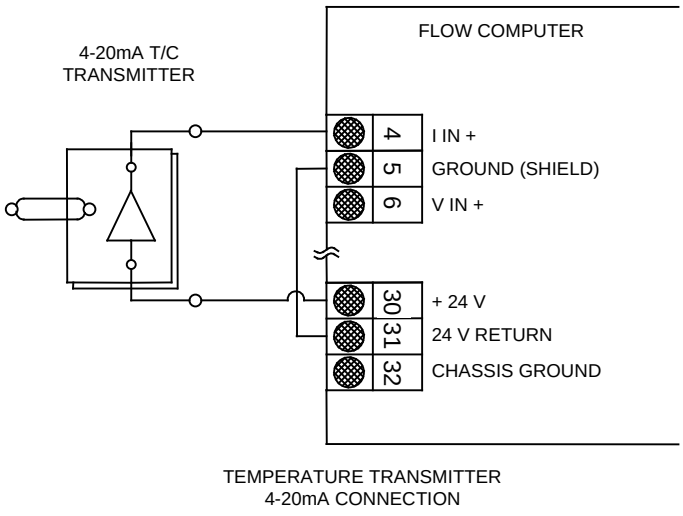


3 WIRE CONNECTION



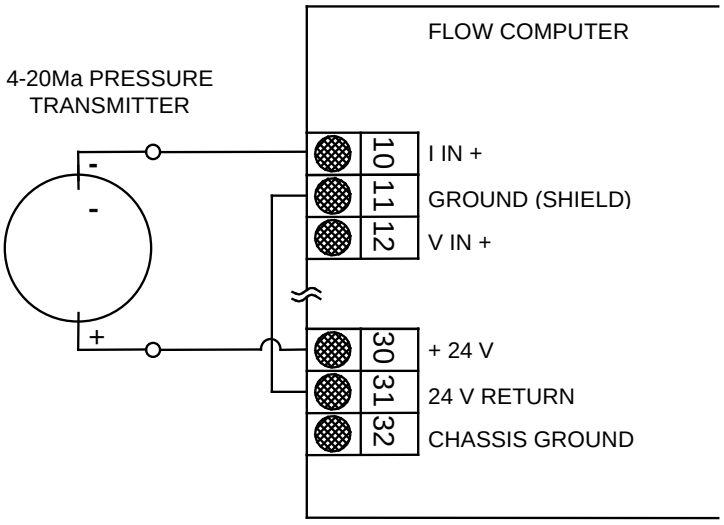
4 WIRE CONNECTION

RTD WIRING DIAGRAMS

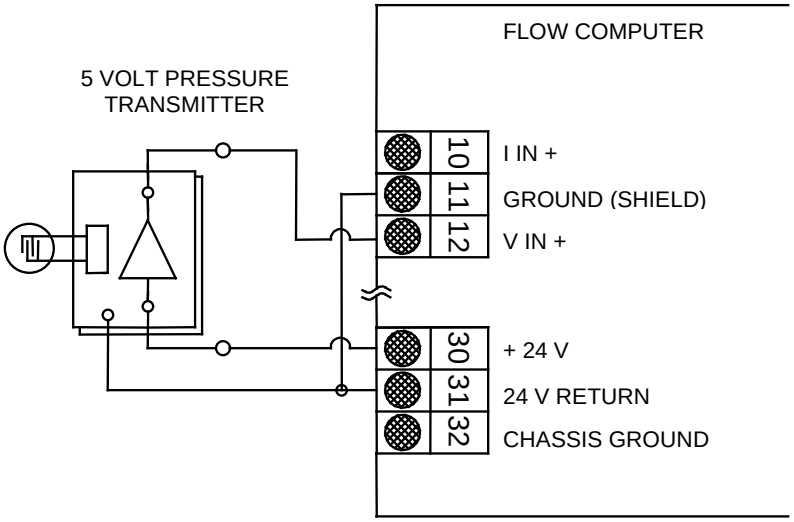


TEMPERATURE TRANSMITTER
4-20mA CONNECTION

Figure 2-4
Temperature Transmitter Input Wiring Diagrams

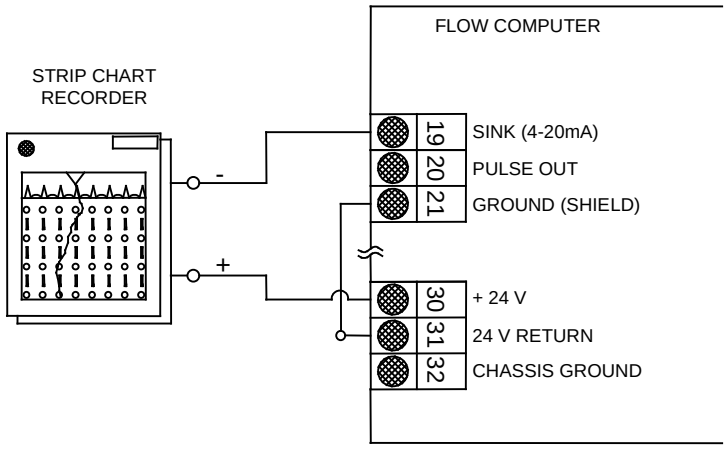


4-20mA CONNECTION



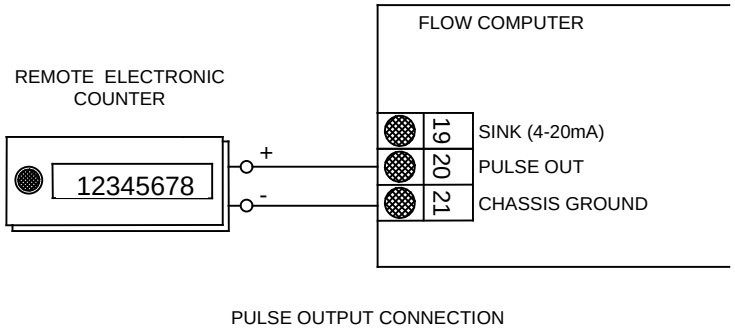
0-5 VOLT CONNECTION

Figure 2-5
Pressure Transmitter
Analog Input Wiring Diagrams



ANALOG OUTPUT CONNECTION

Figure 2-6
Analog Output Wiring Diagram



PULSE OUTPUT CONNECTION

Figure 2-7
Pulse Output Wiring Diagram

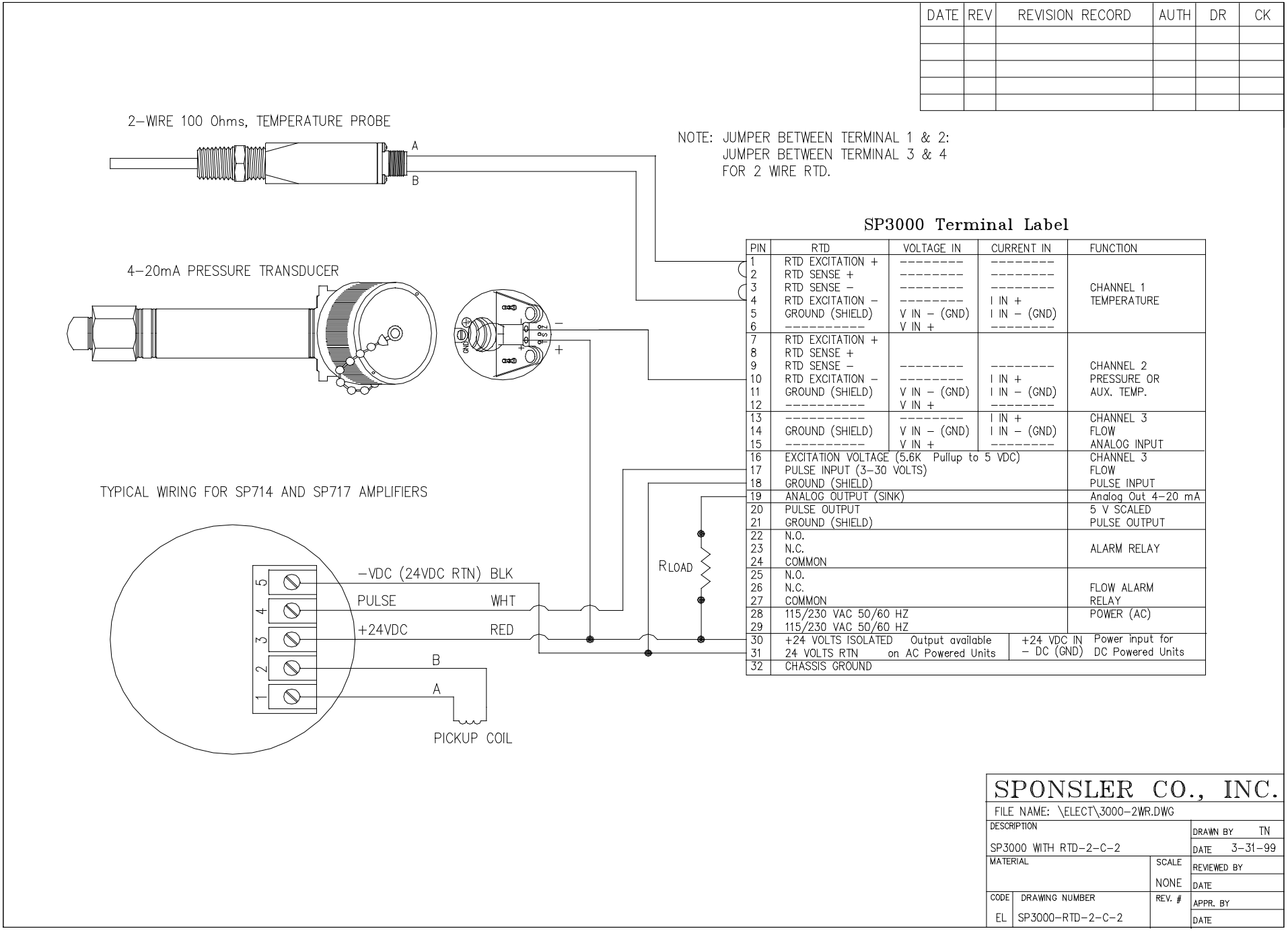


Figure 2-8: Wiring Diagram-2-wire Probe

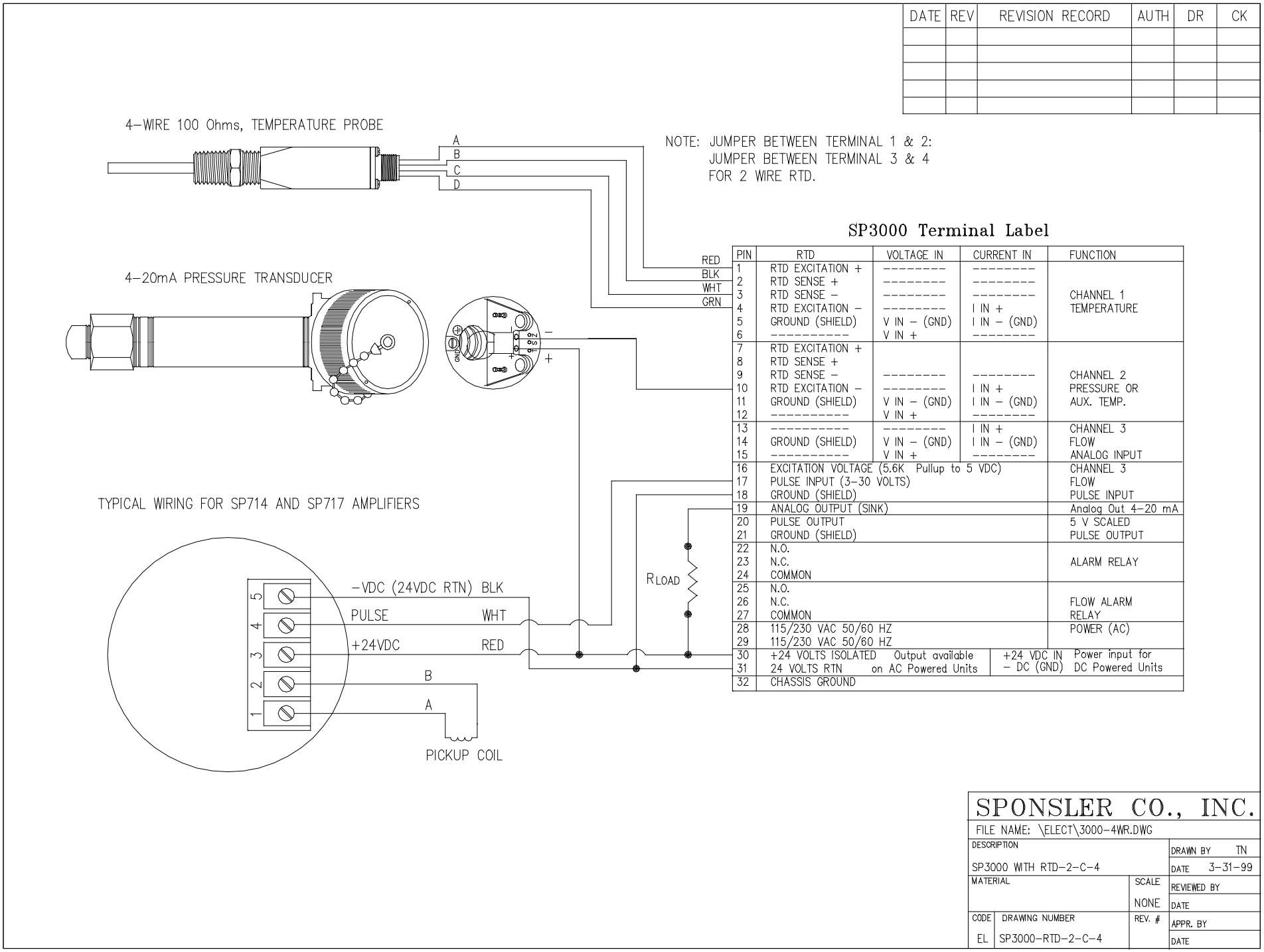


Figure 2-8: Wiring Diagram-2-wire Probe

PROGRAMMING CONSIDERATIONS

Programming the SP3000 Flow Computer for the desired operation is very simple. All programming selections and data entry are accomplished via the 16 keys located and labeled on the front panel. The software in the unit contains two Top Level Menus: "Setup" Menu and "Running" Menu. The "Setup" Menu allows the selection of operating parameters and entry of data variables. The "Computation" selection sets the formulas used to process the raw input data into meaningful information. The "Engineering Units" selection establishes the measuring system that is used for entry and display of the data. The "Hardware" selection sets the type of input data and activates the proper input terminals on the rear of the unit. The unit will automatically determine the setup parameter requirements based on the "Computation" and "Hardware" selections. Prompts are displayed for entry of the required data as the operator progresses through the setup menu. To aid in the setup, a calibration worksheet is provided. Fill out the worksheet before beginning setup. Review this section for setup procedures and follow the worksheet for data to be entered.

The "Running" menu allows the setup of the data display and examination of the programmed operating parameters. The parameters may not be changed in the "Running" menu.

Either menu allows checking the alarm, clearing the totalizer, or accessing the lock.

Structural Division of the two Top Level Menus:

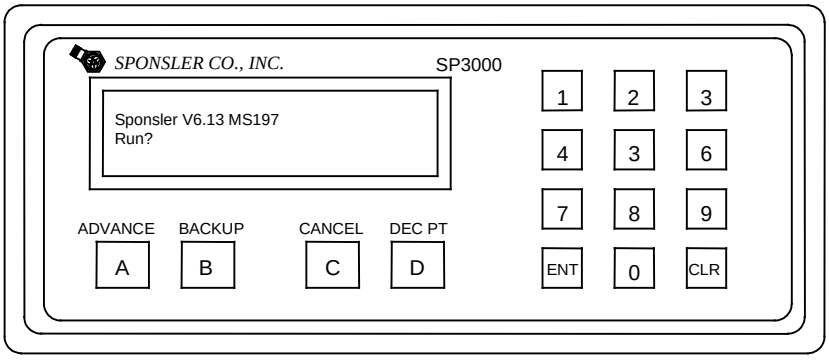
SETUP MODE	**RUNNING MODE**
Sponsler V6.13 MS197	Running...
Run?	Show Data?
	Go To Standby?
Set Computations?	Setup Data Display?
Engineering Units?	Setup Print List?
Set Hardware?	Print System Setup?
Set Variables?	Clear Totalizer?
Clear Totalizer?	Examine Hardware?
Check Alarm?	Examine Comps?
Lock/Unlock?	Examine Variables?
Real Time Clock?	Check Alarm?
Serial Interface?	Lock/Unlock?
Run? Allows crossover from Setup to Run	Go To Standby? Allows crossover from Run to Setup
When in this mode, the operating parameters of the instrument may be set up or changed	When in this mode, the operating parameters may be examined, but no changes may be made

In either mode, check alarm, clear totalizer, or the lock may be accessed.

NOTE: Locking the unit in either mode prevents crossover to the other mode.

3.1 FRONT PANEL KEYPAD OPERATION

Programming is accomplished via the 16 keys labeled and located on the front panel.



The function of each key is described below:

ADVANCE

A — Advances to the next item in the menu or sub-menu. If the last item in the menu is displayed, pressing this button will have no effect on the display. The display will not wrap around to the top of the menu.

BACKUP

B — Backs up to the previous item on the menu or sub-menu. If the first item in the menu is displayed, pressing this button will have no effect on the display. The display will not wrap around to the bottom of the menu.

CANCEL

C — Cancels current operation and goes back to the top of the menu or sub-menu. From any point in the menu structure, pressing “Cancel” twice will always return to Run? Or Show Data? Option.

DEC. PT.

D — Inserts a decimal point in the numerical value being entered.

0 THRU 9 — Keys used to enter numbers. Numerical values appear from left to right as keys are pressed.

CLR — When entering numerical values, pressing this key will erase the last digit typed. If a previously entered value is displayed, pressing this key will erase the entire value.

ENT — Enters a selection or displayed value. If a parameter prompt is displayed, pressing this key will display the value presently in memory. If there is no default or previously stored value, an error message will be displayed.

NOTE: The unit must be in the “Setup” mode to program or change operating parameters. On power up, the unit will return to the mode in which it was operating when power was removed. If the unit was operating in the “Running” mode, the unit will display operating data on the power up. To enter the “Setup” mode:

DISPLAY SHOWS	PRESS
Operating Data Scroll	A
Running... Show Data?	A
Running... Go to Standby?	ENT
Sponsler V6.13 MS197 Run?	(This display indicates that the unit is in the "Setup" mode. If the unit was in the "Setup" mode when the power was removed, the unit will return to this display on power up)

The function keys allow entry to the menus and sub-menus for selecting operating options or entering numerical parameters.

Press	A	To advance a menu or sub-menu
Press	B	To backup a menu or sub-menu
Press	ENT	To access a menu or sub-menu
Press	ENT	To select a displayed option. When an option has been selected, the unit will automatically advance to the next menu item
Press	ENT	To view the previously entered value at any data entry point.
Press	ENT	To erase the last digit typed or to erase a previously entered value
Press	C	To cancel current operation and return to the top of the menu or sub-menu. From any point in the menu structure, pressing C twice will return to the top of the Top Level Menu

3.2 SETTING COMPUTATIONS

The computation selects the formulas that are used to process the raw input data into meaningful information. Section 9 details the formulas used in each computation.

Flow Computation Selection and Applications

Ideal Gas – Volume:	uses volume, temperature and pressure to yield a compensated Volumetric flow rate displayed in SCFM (Nm3/h) and total in SCF (Nm3)
Ideal Gas – Mass:	uses volume, temperature to yield a compensated a Mass flow rate displayed in lbm/h (kg/h) and total lbm (kg)
Steam Tables – Mass:	uses volume and temperature and/or pressure to yield a compensated Mass flow rate displayed in lbm/h (kg/h) and total in lbm (kg). The unit may be set up to follow saturated steam curve; see SPECIAL NOTE on page 3-9. (Steam tables are saturated 1 PSIA to 3200 PSIA with super heated values up to 900^{o}F. Higher temperatures cause an alarm condition).

Liquids – Mass:	uses volume and temperature to yield a compensated Mass flow rate displayed in lbm/min (kg/h) and total in lbm (kg).
Liquids – Volume:	uses volume and temperature to yield a compensated Mass flow rate displayed in GPM (1/s) and total in gallons (liters).
Heat – Gas:	uses volume, pressure and temperature to yield a compensated Mass flow rate displayed in lbm/h (kg/h) and total in lbm (kg) as well as Heat flow rate displayed in Btu/h (kW, kcal/h, MJ/h) and total in kBtu (kWh, Mcal, MJ).
Heat – Steam:	uses volume and pressure and/or temperature to yield a compensated Mass flow rate displayed in lbm/h (kg/h) and total in lbm (kg) as well as Heat flow rate displayed in Btu/h (kW, kcal/h, MJ/h) and total on kBtu (kWh, Mcal, MJ). (Unit may be set up to follow saturated steam curve, see SPECIAL NOTE, pg. 3-9)
Heat – Liquid:	uses volume and temperature to yield a compensated Mass flow rate displayed in lbm/min (kg/h) and total in lbm (kg) as well as Heat flow rate displayed in Btu/h (kW, kcal/h, MJ/h) and total in kBtu (kWh, Mcal, MJ).
Del Heat – Liquids:	uses volume and two temperatures to yield a compensated Mass flow rate displayed in lbm/min (kg/h) and total in lbm (kg) as well as Heat flow rate displayed in Btu/h (kW, kcal/h, MJ/h) and total in kBtu (kWh, Mcal, MJ).

To access the Computation Menu:

Display Shows:	Press:	
Sponsler V6.13 MS197 Run?	A	
Sponsler V6.13 MS197 Set Computations?	ENT	
Flow Computations: Ideal Gas – Volume?	A	to advance the menu
	B	to backup menu
	ENT	to select the displayed computation

The nine options available in the Computations Menu are:

Ideal Gas – Volume?

Ideal Gas – Mass?

Steam Tables – Mass?

Liquids – Mass?

Liquids – Volume?

Heat – Gas?

Heat – Steam?

Heat – Liquid?

Del Heat – Liquids?

3.3 SELECTING THE ENGINEERING UNITS

Engineering units establish the measuring system that is used for entry and display of the operating parameters.

Four options are available to select the desired units for the application:

English (Imperial):	Temperature ^{o}F; Pressure PSI
kPa (Metric):	Temperature ^{o}C; Pressure kPa
Kg/cm^2 (Metric)	Temperature ^{o}C; Pressure kg/cm^2
bar (metric)	Temperature ^{o}C; Pressure bar

NOTE: The output data display units and the required variable units are determined by the Computation and Engineering Units selected. A complete listing of input and output data units is given in Appendix i.

To enter the Engineering Units Menu:

Display Shows:	Press:	
Sponsler V6.13 MS197 Engineering Units?	ENT	
Engineering Units? English?	A	To advance menu
	B	To backup menu
	ENT	To select displayed option

Engineering Units Menu:

Engineering Units:
English?

Engineering Units:
kPa (Metric)?

Engineering Units:
kg/cm^2 (Metric)?

Engineering Units:
bar (Metric)?

3.4 SETTING THE HARDWARE

The hardware selection determines the input terminals from which the unit will accept raw data. Internal analog switches activate the proper terminals for the input type selected. Review the specification sheet for each input device being used with the system to determine the required selection.

To access the Hardware Menu:

Display Shows:	Press:
Sponsler V6.13 MS197 Set Hardware?	ENT

Input Configuration:
Pressure?

[A] To advance Input Configuration Menu

[ENT] To access Pressure Input Type Menu

Flowchart Representation of Hardware Menu:

Sponsler V6.13 MS197
Set Hardware?

[ENT]

Input Configuration?
Pressure? → [A] Input Configuration?
Temperature? → [A] Input Configuration?
Flow?

[ENT] [ENT] [ENT]

Input Type:
5 Volts?
10 Volts?
0-20mA?
4-20mA?

Input Type:
5 Volts?
10 Volts?
0-20mA?
4-20mA?
RTD (100 ohms)

Input Type:
5 Volts?
10 Volts?
0-20mA?
4-20mA?
Digital Pulse

or*

Sub-Menu

Input Configuration:
Temperature two?

[ENT]

Flowmeter Type:
Linear?
Orifice/Pitot?
Sixteen Point?

Input type:
5 Volts?
10 Volts?
0-20mA?
4-20mA?
RTD (100 ohms)?

* Channel 2 may be a pressure or temperature input depending on which computation is selected. The pressure sub-menu is replaced by the temperature two sub-menu if the Del-Heat-Liquids Computation is selected.

NOTE:
The pressure input is always the gage pressure of the line. Differential pressure is selected under the flow input type.
Input type “5 Volts?” is a 0 to 5 volt signal. 1 to 5 volt signals cannot be handled properly due to software constraints.
Input type “10 Volts?” is a 0-10 volt signal.
The flowmeter type sub-menu directly follows the flow input type.
Flowmeter types:
LINEAR is selected whenever the signal from the flowmeter is linear over the operating range.
ORIFICE/PITOT is the selection when the signal from the flowmeter represents a square law differential pressure. This type is not available when Digital Pulse is selected as the input type.
SIXTEEN POINT is for compensating any other type on non-linear input signals.
* * BE SURE THAT INPUT DEVICES ARE WIRED TO THE PROPER TERMINALS. IF HARDWARE SELECTION DOES NOT MATCH WIRING, THE RESULT WILL BE ERRONEOUS READINGS.

3.5 SETTING THE VARIABLES

The variables determine how the input signals are interpreted by the software to display and output the compensated flow. The parameters required for proper calculation are determined by the Computation, Engineering Units, and Hardware Selections. The unit will automatically prompt for the required parameters.

Use the numeric keypad to input the required variables. The [D] key sets the decimal point when entering a numerical value. The [CLR] key acts as a backspace (erases the last digit typed) when entering a numerical value. The [ENT] key enters the data into memory.

To access the Variable Menu:

Display Shows:	Press:	
Sponsler V6.13 MS197 Set Variables?	[ENT]	
Select Setup Item: Pressure input	[A]	to advance Variable Menu
	[B]	to backup menu
	[ENT]	to access Pressure input sub-menu

3.51 SETTING THE PRESSURE VARIABLES

The Pressure Variables determine how the input signals from channel 2 are interpreted. The Pressure sub-menu is the same for all Computation and Hardware selections. The Engineering units selected determine the pressure input units. The pressure input is always the gage pressure of the line.

NOTE:
The Pressure sub-menu is replaced by a second temperature sub-menu if the Computation is Del-Heat-Liquids.

The Pressure input is not required for Liquids-Mass or Volume computations. The functionality of the input terminals and the sub-menu remain active and may be used if desired.

The Pressure Input Sub-menu & Definitions of Required Data:

Select Setup Item:
Pressure input?

[ENT]

At input = Minimum Lo press?	--	Enter the gage pressure value represented by the lowest analog input (i.e. 4mA=10 PSIG. Enter 10)
At input = Maximum Hi press?	--	Enter the gage pressure value represented by the highest analog input (i.e. 20mA=500 PSIG. Enter 10)
Atmospheric Pressure Barometric?	--	This value is added to the input gage pressure to calculate the absolute pressure value (i.e. 14.696 PSIA. Enter 14.696)

	Press alarm set point Lo alarm?	--	Enter Low Pressure value at which the unit activates an alarm relay (i.e. 5PSIG. Enter 5. Alarm relay is activated when pressure input indicates 5 PSIG)
	Press alarm set point Hi alarm?	--	Enter High Pressure value at which the unit activates an alarm relay (i.e. 500 PSIG. Enter 500. Alarm relay is activated when pressure input indicates 500 PSIG)

SPECIAL NOTE: To set the flow computer to follow the saturated steam curve with

1. Pressure and No temperature inputs: set Lo temp = 0.00 and Hi temp = 0.00. The flow computer will use the pressure input to look up the corresponding temperature on the saturated steam table for calculations and display.
2. Temperature and No pressure input: set Lo press = 0.00 and Hi press = 0.00. The flow computer will use the temperature input to look up the corresponding pressure on the saturated steam table for calculations and display.

3.52 SETTING THE TEMPERATURE VARIABLES

The temperature variables determine how the input signals from channel 1 * are interpreted. The temperature sub-menu is determined by the Computation and Hardware selections.

NOTE:
* The Pressure sub-menu is replaced by Temperature 2 sub-menu if the Computation is Del-Heat-Liquids. Follow the same setup procedure as outlined in this section.

Entering Negative Values:
A leading minus sign may be entered by pressing the [0] key as the first keystroke when entering a numerical temperature value.

Subsequent strokes of the [0] key will enter zero into the number as usual. The [0] key acts conventionally in all other variable sub-menus.

The Temperature Input Sub-menu & Definitions of Required Data:

Select Setup item:
Temperature input?

[ENT]

NOTES			
1	At input = Minimum Lo temp?	--	Enter the temperature value represented by the lowest analog output (i.e. 4mA=32^{o} F. Enter 32)
1	At input = Maximum Hi temp?	--	Enter the temperature value represented by the highest analog input (i.e. 20mA=240^{o}F. Enter 240)
2	Base Reference Temperature?	--	Enter the temperature value at which the specific gravity is measured (i.e. 60^{o}F. Enter 60)
	Temp alarm set point Lo alarm?	--	Enter Low Temperature value at which the unit activates an alarm relay (i.e. 20^{o} F. Enter 20. Alarm relay is activated when temperature input indicates a temperature of 20^{o} F)
	Temp alarm set point Hi alarm?	--	Enter High Temperature value at which the unit activates an alarm relay (i.e. 850^{o} F. Enter 850. Alarm relay is activated when pressure input indicates a temperature of 850^{o} F)

Notes:

1. These prompts do not appear if Hardware is RTD (100 ohms). The resistance input is referenced to a look-up table to determine the temperature.
2. This prompt appears if a liquid computation is selected (Liquid-Mass, Liquid-Volume, Heat-Liquid, Del Heat-Liquids).

3.53 SETTING THE FLOW VARIABLES

The Flow variables determine how the input signals from channel 3 are interpreted. The flow input sub-menu will only prompt for the required variables as determined by the Computation and Hardware selections. Flowcharts showing complete sub-menu prompts are given for each of the Hardware selections. Use the flowchart corresponding to the Hardware selected and observe notes as to which variables are required for the Computation selected.

HARDWARE SELECTIONS

Input Type	Use Flow Chart	Page
Digital Pulse-Linear	3.54	3-10
Digital Pulse-Sixteen Point	3.55	3-11
Analog-Linear	3.6	3-15
Analog-Sixteen Point	3.61	3-16

3.54 FLOWCHART: DIGITAL PULSE-LINEAR

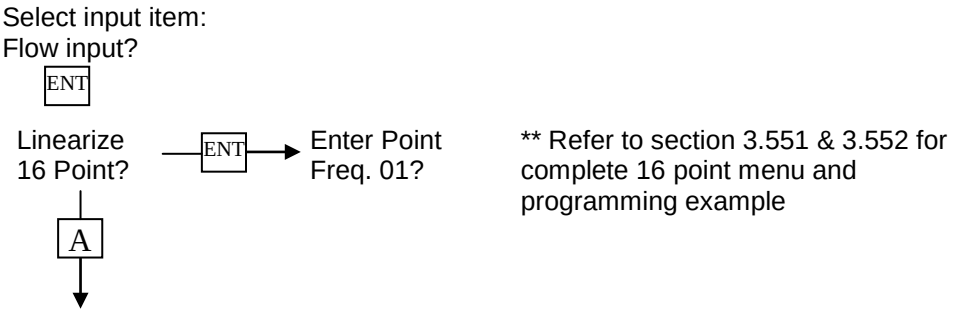
Select Setup item:
Flow input?

ENT

NOTES		
	Pulses per unit vol. K-Factor?	Enter the K-Factor (Pulses per unit volume) from the flowmeter calibration data sheet
1	Gas compressibility Z Factor?	Enter the Compressibility factor of the gas being measured
2	Specific gravity Gravity?	Enter the specific gravity constant calculated at Standard or the Base Reference Temperature for the product being measured
3	Thermal Expansion C(X10E-6)?	Enter the thermal coefficient of expansion for the liquid being measured
4	Mean Spec Heat?	Enter the constant value for the ability of the liquid to retain heat.
	Cutoff: 0 to 40 KHz Input filter?	Enter the highest pulse rate (frequency) at which the unit will accept pulses. Higher pulse rates are ignored. NOTE: Also determines the minimum pulse width required
	Flow alarm set point Lo alarm?	Enter the low compensated flowrate value at which the flow alarm relay will activate
	Flow alarm set point Hi alarm?	Enter the high compensated flowrate value at which the flow alarm relay will activate

NOTES:
1. Used in Ideal Gas equation only.
2. Not used in Idea Gas-Volume or Steam equations.
3. Used in Liquids equations only.
4. Used in Heat-Gas, Del-Heat-Liquids and Heat-Mass equations only.

3.55 FLOWCHART: DIGITAL PULSE- SIXTEEN POINT



NOTES		
1	Gas Compressibility Z Factor?	Enter the compressibility factor of the gas being measured
2	Specific gravity Gravity?	Enter the specific gravity constant calculated at Standard or the Base reference temperature for the product being measured
3	Thermal Expansion C(X10E-6)?	Enter the Thermal Coefficient of Expansion for the liquid being measured
4	Mean Spec Heat?	Enter the constant value for the ability of the liquid to retain heat
	Cutoff: 0 to 40 KHz Input filter?	Enter the highest pulse rate (frequency) at which the unit will accept pulses. Higher pulse rates are ignored. NOTE: Also determines the minimum pulse width required
	Flow alarm set point Lo alarm?	Enter the low compensated flowrate value at which the flow alarm relay will activate
	Flow alarm set point Hi alarm?	Enter the high compensated flowrate value at which the flow alarm relay will activate

NOTES:
1. Used in Ideal Gas equations only.
2. Not used in Ideal Gas-Volume or Steam equations.
3. Used in Liquids equations only.
4. Used in Heat-Gas, Del Heat-Liquids, and Heat-Mass equations only.

3.551 DIGITAL PULSE – SIXTEEN POINT PROGRAMMING

The 16 Point Linearization is used when the flowmeter gives a non-linear signal. The unit uses up to 16 different frequency and K-Factor entries to form a curve for linearizing the input signal.

SPONSLER, INC. STRONGLY RECOMMENDS THOROUGH REVIEW AND UNDERSTANDING OF THIS SECTION PRIOR TO PROGRAMMING THE 16 POINT MENU.

NOTES:

1 A minimum of three points must be set up.

2. If two consecutive input values or K-Factors are set to zero, extrapolation is taken from the last two non-zero points to determine a K-Factor used for calculations.

3. If the input frequency is above the highest or below the lowest frequency programmed, the unit will use the last two points to extrapolate the K-Factor and calculate the resulting actual flow. Care must be taken that the K-Factor doesn't extrapolate to zero. If this happens, the unit will give erroneous readings. To avoid this occurrence, program point 01 frequency at zero and point 01 K-Factor at the same K-Factor for the lowest input frequency as listed in the flowmeter calibration sheet.

4. Frequencies must be entered in ascending order.

5. The 16 point option will <u>not</u> override the cutoff Input Filter frequency entered elsewhere in the Flow Variables menu.

6. Press the [C] button when the desired number of points are entered. This will exit the 16 Point Setup routine and return to "Set Variables?" heading. If all 16 points are programmed, the unit will automatically advance to the next required Setup item.

3.552 PROGRAMMING EXAMPLE: `Flowchart: Digital Pulse – Sixteen Point

**NOTE: This is an example of 16 point programming using calibration data for turbine Serial No. 107221. (See next page) Actual Calibration data must be entered for the specific turbine flowmeter used with the unit.

Select Setup item:
Flow input?

ENT

Linearize
16 point?

ENT

Enter point Freq 01?	Press 0 Press ENT
Freq 01? 0.0000 K-Factor 01?	Press 1383067 Press ENT
Enter point Freq. 02?	Press 32 Press ENT
Freq 02? 32.0000 K-Factor 02?	Press 1383067 Press ENT
Enter point Freq 03?	Press 148 Press ENT
Freq 03? 148.0000 K-Factor 03?	Press 2160356 Press ENT
Enter point Freq 04?	Press 259 Press ENT
Freq. 04? 259.0000 K-Factor 04?	Press 2161185 Press ENT
Enter point Freq 05?	Press 377 Press ENT
Freq 05? 377.0000 K-Factor 05?	Press 2203285 Press ENT
Enter point Freq 06?	Press 492 Press ENT
Freq 06? 492.000 K-Factor 06?	Press 2224646 Press ENT
Enter point Freq. 07?	Press 601 Press ENT
Freq 07? 601.000 K-Factor 07?	Press 2235430 Press ENT
Enter point Freq 08?	Press 723 Press ENT
Freq 08? 732.0000 K-Factor 08?	Press 2256791 Press ENT
Enter point Freq 09?	Press 834 Press ENT
Freq 09? 834.0000 K-Factor 09?	Press 2274834 Press ENT
Enter point Freq 10?	Press 948 Press ENT
Freq 10? 958.0000 K-Factor 10?	Press 2303039 Press ENT
Enter point Freq 11?	Press 1058 Press ENT
Freq 11? 1058.0000 K-Factor 11?	Press 2323958 Press ENT
Enter point Freq 12?	Press 1290 Press ENT
Freq 12? 1290.0000 K-Factor 12?	Press 2384127 Press ENT
Enter point Freq 13?	Press 1514 Press ENT
Freq 13? 1514.0000 K-Factor 13?	Press 2417309 Press ENT
Enter point Freq 14?	Press 1741 Press ENT
Freq 14? 1741.0000 K-Factor 14?	Press 2440122 Press ENT
Enter point Freq 15?	Press 1966 Press ENT
Freq 15? 1966.0000 K-Factor 15?	Press 2458372 Press ENT
Enter point Freq 16?	Press 2195 Press ENT
Freq 16? 2196.0000 K-Factor 16?	Press 2479318 Press ENT
Gas Compressibility Z Factor	

NOTE: To view the previously entered value at any data entry point, press ENT. The stored value will display. If the display value doesn't need to be changed, press ENT. The value will be retained and the unit will automatically advance to the next data entry point. If the value needs to be changed, press CLR. Press the number keys to display the desired value to be entered, then press ENT. The value will be stored and the unit will automatically advance to the next data entry point.

WORK ORDER #: 9334

SPONSLER CO., INC.
2363 SANDIFER BLVD.
WESTMINSTER S.C. 29693
USA

CALIBRATION #: 1
FLUID: AIR
TEST STAND NO.: 2
CALIBRATED BY: HR
DATE: 13-Jan-92

SERIAL NO.: 107211
HOUSING MATERIAL: 304
ROTOR MATERIAL: 17-4
BEARINGS: CRYO
COIL NO.:RF22M 1ea.

MODEL NO.: MF40-CB-PH-1/4A-4RFX

PT.	WEIGHT LBS.	VOL.GALLONS SP.GR.1.000	(TRUE) SP.GR.	TEMP. DEG.FAR.	TRUE VOL. ACFM	RATE ACFM	TIME SECONDS	TOTAL CYCLES	APPROX. FREQ. CPS	"K" CPFT3	16 PT
1	0.30000	0.036022	0.9986	65	0.004822	0.0531	5.447	11955	2195	2479318.1	16
2						0.0507	5.710	11917	2087	2471437.4	
3						0.0480	6.030	11854	1966	2458372.0	15
4						0.0456	6.345	11807	1861	2448624.8	
5						0.0428	6.760	11766	1741	2440121.9	14
6						0.0404	7.166	11732	1637	2433070.7	
7						0.0376	7.698	11656	1514	2417309.2	13
8						0.0350	8.267	11560	1398	2397400.0	
9						0.0325	8.909	11496	1290	2384127.2	12
10						0.0301	9.605	11299	1176	2343271.9	
11						0.0273	10.589	11206	1058	2323984.8	11
12						0.0247	11.720	11105	948	2303038.7	10
13						0.0220	13.147	10969	834	2274834.0	09
14						0.0192	15.058	10882	723	2256791.3	08
15						0.0161	17.918	10779	601	2235430.4	07
16						0.0133	21.816	10727	492	2224646.2	06
17						0.0103	28.192	10624	377	2203285.3	05
18						0.0072	40.221	10421	259	2161185.6	04
19						0.0041	70.417	10417	148	2160356.1	03
20						0.0014	208.145	6669	32	1383067.5	02
									0	1383067.5	01*

MEAN TOTAL CYCLES (PER WEIGHT USED):
SENSING ELEMENT CONSTANT (MEAN CYCLES/ACF):

NOTE: 16 Point Linearization frequency points must be in ascending order. Disregard the PT column on the left; Calibration Data points are in descending order.

Establish the points that require linearization based on the flowrate range required and the non-linearity of the specific meter.

* Point 01 frequency should be “0”, with K-Factor of lowest frequency listed.

3.6 ANALOG LINEAR INPUT SETTINGS

Graphical representation of the Analog Linear sub-menu

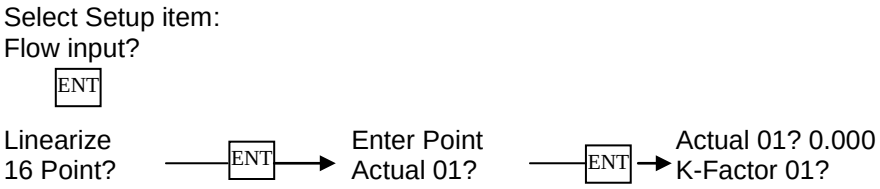
Select Setup item:
Flow input?

ENT

NOTES		
1	Gas compressibility Z Factor?	Enter the compressibility factor of the gas being measured
2	Specific gravity Gravity?	Enter the specific gravity constant calculated at standard or the Base Reference Temperature for the product being measured
	At input = minimum Lo flow?	Enter the flow value at which the analog input is lowest (i.e. no flow = 4.00mA. Enter 0)
	At input = maximum Hi flow?	Enter the flow value at which the analog input is highest (i.e. 300 m^3/hr = 20.00mA. Enter 300)
	Low flow Cutoff?	Enter the lowest flow value below which any calculations are unnecessary. For example, a small leakage when valve is closed to be ignored
3	Thermal Expansion C(X10E-6)?	Enter the Thermal Coefficient of Expansion for the liquid being measured
4	Mean Spec Heat?	Enter the constant value for the ability of the liquid to retain heat
	Flow alarm set point Lo alarm?	Enter the low compensated flowrate value at which the flow alarm relay will activate
	Flow alarm set point Hi alarm?	Enter the high compensated flowrate value at which the flow alarm relay will activate

NOTES:
1. Used in Ideal Gas equations only.
2. Not used in Ideal Gas-Volume or Steam equations.
3. Used in Liquids equations only.
4. Used in Heat-Gas, Del Heat-Liquids, and Heat-Liquids equations only.

3.61 ANALOG 16 POINT INPUT SETTINGS



NOTES

1	Gas compressibility Z Factor?	Enter the compressibility factor of the gas being measured
2	Specific gravity Gravity?	Enter the specific gravity constant calculated at standard or the Base Reference Temperature for the product being measured
	At input = minimum Lo flow?	Enter the flow value at which the analog input is lowest (i.e. no flow = 4.00mA. Enter 0)
	At input = maximum Hi flow?	Enter the flow value at which the analog input is highest (i.e. 300 m^3/hr = 20.00mA. Enter 300)
	Low flow Cutoff?	Enter the lowest flow value below which any calculations are unnecessary. For example, a small leakage when valve is closed to be ignored
3	Thermal Expansion C(X10E-6)?	Enter the Thermal Coefficient of Expansion for the liquid being measured
4	Mean Spec Heat?	Enter the constant value for the ability of the liquid to retain heat
	Flow alarm set point Lo alarm?	Enter the low compensated flowrate value at which the flow alarm relay will activate
	Flow alarm set point Hi alarm?	Enter the high compensated flowrate value at which the flow alarm relay will activate

NOTES:
1. Used in Ideal Gas equations only.
2. Not used in Ideal Gas-Volume or Steam equations.
3. Used in Liquids equations only.
4. Used in Heat-Gas, Del Heat-Liquids, and Heat-Liquids equations only.

3.7 ANALOG ORIFICE/PITOT INPUT SETTINGS

Graphical representation of the Analog Orifice/Pitot sub-menu

Select Setup item:
Flow input?

ENT

NOTES

1 Gas compressibility
Z Factor?

2 Specific gravity
Gravity?

Meter compensation
Factor (K1)?

At input = minimum
Delta P lo?

At input = maximum
Delta P hi?

Low Flow
Cutoff?

3 Thermal Expansion
C(X10E-6)?

4 Mean
Spec Heat?

Flow alarm set point
Lo alarm?

Flow alarm set point
Hi alarm?

NOTES:
1. Used in Ideal Gas equations only.
2. Not used in Steam equations only.
3. Used in Liquids equations only.
4. Used in Heat-Gas, Del Heat-Liquids, and Heat-Liquids equations only.

3.8 SETTING THE FLOW OUTPUT VARIABLES

The Flow Output Variables determine how the output signals reflect the compensated flow. The Flow Output sub-menu is the same for all Computation or Hardware Selections.

NOTE: It is not necessary to set up the Flow Output if it is not required.

Select Setup item:
Flow Output?

ENT

Flow at 4mA out Min flow?	Enter the compensated Flow Rate value to be represented by 4mA output
Flow at 20mA out Max flow?	Enter the compensated Flow Rate value to be represented by 20mA output
Digital pulse out Scaling?	Enter a multiplying factor for the 5V digital pulse output. This factor multiplies the incremental counts of the flow totalizer and outputs a pulse as required. EXAMPLE: Scaling factor of 0.1 outputs one pulse for every 10 increments of the flow totalizer. Scaling factor of 10 outputs ten pulses for each increment of the flow totalizer (maximum Output rate is 50 kHz).

CLEARING THE TOTALIZER: RESETTING THE TOTALIZER TO 0.000

The totalizer can be cleared (reset to zero) in either of the two top-level menus: “Setup” or “Running”.

NOTE: The totalizer accumulates only while the unit is in the “Running” side of the menu.

To clear Totalizer in “Setup” menu:

Sponsler V6.13 MS197
Run?

A

Sponsler V6.13 MS197
Set Computations?

A

Sponsler V6.13 MS197
Engineering Units?

A

Sponsler V6.13 MS197
Set Hardware?

A

Sponsler V6.13 MS197
Set Variables?

A

Sponsler V6.13 MS197
Clear Totalizer?

ENT

Totalizer Cleared — This message is momentarily displayed to verify that the totalizer is cleared. The menu then advances to the next item

Sponsler V6.13 MS197
Check Alarm?

* To Clear Totalizer in “Running” Menu:

Press A

Running...
Show Data?

A

Running...
Go To Standby?

A

Running...
Setup Display?

A

Running...
Setup Print List?

A

Running...
Print System Setup?

A

Running...
Clear Totalizer?

ENT

Totalizer Cleared — This message is momentarily displayed to verify that the totalizer is cleared. The unit then returns to the top of the menu.

Running...
Show Data?

A

CHECKING THE ALARM: VIEW THE MOST RECENT ALARM CONDITION

If the alarm should go off, the point which went into alarm most recently may be checked and quieted from either of the Top-Level menus.

To Check the Alarm in “Setup” Menu:

Sponsler V6.13 MS197
Run?

[A]

Sponsler V6.13 MS197
Set Computations?

[A]

Sponsler V6.13 MS197
Engineering Units?

[A]

Sponsler V6.13 MS197
Set Hardware?

[A]

Sponsler V6.13 MS197
Set Variables?

[A]

Sponsler V6.13 MS197
Clear Totalizer?

[A]

Sponsler V6.13 MS197
Check Alarm?

[ENT]

Alarm Condition
Press ENT to Quiet

The most recent alarm condition will be displayed on the top line. Pressing [ENT] will de-energize the corresponding alarm relay. If The condition that caused the alarm still exists When the unit is returned to “Running” mode, The alarm relay will again energize.

[ENT]

Alarm Condition
Alarm Cleared

Momentarily displayed to indicate the alarm has been cleared.
The unit automatically advances to the next menu.

Sponsler V6.13 MS197
Lock/Unlock?

To check that no other alarm condition exists, press [B] to backup to the check alarm option.

[B]

Sponsler V6.13 MS197
Check Alarm?

[ENT]

No Alarm Condition

Momentarily displayed to indicate that no alarm conditions exist. The unit will automatically advance to the next menu.

Sponsler V6.13 MS197
Lock/Unlock?

LOCK/UNLOCK

Lock is used to prevent unwanted changes to programming. No changes through the front panel or RS-232 port can be made while the unit is locked. The lock may be initialized in either the "Setup" or "Running" mode. Once the unit is locked, the operating mode can't be changed. If unit is locked in "Setup" mode, "Running" mode can't be accessed. If the unit is locked in "Running" mode, "Setup" mode can't be accessed.

NOTE: Any 5 digit security code (except 00000) may be used to lock the unit. The same 5 digit code must be entered to unlock the unit. Place the 5 digit security code used to lock the unit in a safe location for future reference.

To Lock:

Advance or Backup the menu until the display indicates:

Sponsler V6.13 MS197 Lock/Unlock	or Press ENT	Running... Lock/Unlock?
Machine is unlocked Enter code:		Enter a 5 digit code number (NOTE: Code may NOT be 00000). As each digit is pressed an "*" will appear on the display to verify that the digit has been entered.
Machine is unlocked Enter code: *****		As soon as the fifth digit is entered, 5 "*"s will be displayed momentarily. The unit will then advance to "Now confirm:"
Machine is unlocked Now confirm:		Enter the 5 digit code again
Machine is unlocked Now confirm: *****		As soon as the fifth digit is entered, 5 "8"s will be displayed momentarily. The unit will lock and then advance to the next menu item.
Sponsler V6.13 MS197 Real time clock?	or	Running... Show Data?

After the lock has been initiated in the "Setup" mode, only ":Check alarm?" or "Lock/Unlock" may be accessed. Any attempt to enter one of the programming menus or the "Running" mode will display:

****Locked!!****
Push ENT to continue

In the "Running" mode the lock prevents access to "Go to Standby?" and "Clear Totalizer?". All other functions of the "Running" menu remain accessible.

To Unlock:

Advance or Backup the menu until the display indicates:

Sponsler V6.13 MS197 Lock/Unlock	or Press ENT	Running... Lock/Unlock?
Machine is locked Enter code:		Enter the 5 digit code number. No confirming step is required to unlock the unit.
Machine is locked Enter code: *****		The unit will unlock and then advance to the next menu item as soon as the correct code is entered.
Sponsler V6.13 MS197 Real time clock?	or	Running... Show Data?

Note: Bad lock code Push ENT to continue	This error message may display after the entry of the 5 digit code in the lock/unlock procedure. Pressing enter will exit the Lock/Unlock menu option and advance to the next menu item.

REAL TIME CLOCK

The SP3000 has a real time clock and calendar that can be set from the front keypad while the unit is in the "Setup" mode. The clock cannot be set while in the "Running" mode. The time and date are saved upon power down: however, there is no battery backup to update the time and date during loss of power.

NOTE: The time must be in 24 hour format.
Enter hours (00-23) and minutes (00-59) based on 24 hour clock.
Example: 2:32 p.m. must be entered as 14:32 (Decimal point must be entered between hour and minutes).

Advance "Setup" menu until display indicates:
Sponsler V6.13 MS197
Real time clock?

ENT

Select item:
Set time?

ENT

Enter time: Hr. Min?	Enter the correct hour and minutes based on 24 hour clock. Example: 14 D 32 (2:32 p.m.) Press ENT

Select item:
Set date?

ENT

Enter date: Mo. Da. Yr. ?	Enter the correct date in the format: Month (1-12). Date (1-31). Year (00-99) Example: 4 D 23 D 92 (April 23, 1992) Press ENT
Sponsler V6.13 MS197 Serial Interface?	The unit will automatically advance to the next menu item.

NOTE:	Bad Time value Push ENT to continue or Bad Date value Push ENT to continue	Error messages indicating that the numerical value entered is invalid.
	Syntax error Push ENT to continue	Error message indicating that the numerical values are not entered in the correct format.

RUNNING MODE

The “Running” mode is the normal operating mode for the SP3000. Flow measurement is performed only in the “Running” mode.

Top Level Running Menu:

Running... Show Data?	Press ENT to activate the live display of flow data
Running... Go to Standby?	Press ENT to access the “Setup” mode for setting variables
Running... Setup data display?	Press ENT to program the order of the live display
Running... Setup print list?	Used with RS-232 option to select the items printed out the serial port
Running... Print System setup?	Used with RS-232 option to print out all parameter values out the serial port
Running... Clear Totalizer?	Press ENT to reset the Totalizer to 0.000
Running... Examine Hardware?	Press ENT to view the Hardware configurations for the Temperature, Pressure, and Flow Inputs
Running... Examine Comps?	Press ENT to view the Flow Computation selected
Running... Examine Variables?	Press ENT to view the input variables configurations
Running... Check Alarm?	Press ENT to view the most recent alarm condition
Running... Lock/Unlock?	Press ENT to access and change the lock function

8.1 SHOW DATA

This menu item will start the data list scrolling on the LCD display. The order of display for up to 16 items can be designated in the "Setup data display?" menu. Each item can be displayed more than once in the scan list. Each item will be displayed for approximately two seconds. If an item requires longer display time, it may be selected for consecutive display points.

The parameters available for display selection (from a total of 19) are dependent upon the Computation and Hardware setup. The system automatically determines the data available for display based on the programmed parameters.

DISPLAY DATA DESCRIPTIONS:

1.	Time and Date	Current time and date
2.	Flow Rate	Filtered & Compensated with engineering units
3.	Mass Flow	Filtered & Compensated with engineering units
4.	Heat Flow	Filtered & Compensated with engineering units
5.	Totalizer	Compensated accumulated flow with engineering units
6.	Totalizer	(Mass) Compensated accumulated flow
7.	Heat Totalizer	Compensated accumulated heat flow
8.	Temperature	Filtered & Scaled temperature in degrees
9.	Pressure	Filtered & Scaled pressure in units of measurement
10.	Uncompensated Flow	Filtered but not compensated with engineering units
11.	Raw Flow (Channel 3)	Analog value of flow input
12.	Raw Pressure (Channel 2)	Raw analog value of pressure input
13.	Raw Temperature (Channel 1)	Raw analog value of temperature input
14.	Raw RTD Input 1	Raw analog value of RTD input in mA
15.	RTD Ohms (Channel 1)	Resistance of RTD
16.	Analog Output	Output value in mA
17.	Specific Volume	Current specific volume from Steam Tables
18.	Specific Heat	Current specific heat from Steam Tables
19.	Flow Frequency	Raw input pulse frequency

8.1.1 DISPLAY DATA SETUP

Running...
Show Data?

[A]

Running...
Go to Standby?

[A]

Running...
Setup data display?

[ENT]

Select item #1
Time & Date? Press [A] to advance the list of data available for display

Press [B] to backup the list of data available for display

Press [ENT] to select the data for display. The item # will increment as each selection is made

Continue to advance or backup the list and select desired data for display

NOTE: Up to 16 display items may be selected. Pressing the [C] button exits the routine and returns to "Show Data?" when the desired number of display items is entered. If 16 items are entered, the unit exits the routine and returns to "Show Data?" upon entering item 16.
(DISREGARD IF RS-232 OPTION IS NOT INSTALLED IN UNIT)

8.2 PRINT LIST (RS-232 OPTION)

During normal operation, the instrument may be set up to print out, through the RS-232 port, the important operating data such as flow rate, temperature, or pressure. The same data that is available for display can be scanned and printed out the serial port of the instrument.

The operator can designate up to 16 items of this list that will be printed, and in which order they will be printed. NOTE: Each item can be selected more than once in the print list even though there is no advantage to doing this.

Use the same procedure and the same list to set up the list of items to print as used for setting up the display list. (Refer to previous section 8-11)

(Select the item by pressing the [ENT] key while the item is displayed.

For Example:

DISPLAY:	PRESS:
Select item #1 Flow Rate	[ENT]
Select item #2 Totalizer	[ENT]
Select item #3 Temperature	[A]
Select item #3 Pressure	[ENT]

Continue the process until a list of all the parameters to print while the instrument is running has been established. Use the [C] key to break out of the menu after the list is created. Make sure that the Print Interval and the serial port have been activated in the Standby Menu for enabling this feature.

8.3 PRINT SYSTEM SETUP (RS-232 OPTION)

This feature is for use in documentation. When this menu item is selected, an entire print out of all the user defined parameters is sent out the RS-232 port.

DISPLAY:	PRESS:
Running... Show Data?	[A]
Running... Go to Standby?	[A]
Continue Pressing [A] until:	
Running... Print system setup?	[ENT]

A system dump of the parameters through the RS-232 serial communications port is performed.

8.4 EXAMINE HARDWARE

This feature is used to examine how the hardware configuration of the unit has been set up.

DISPLAY:	PRESS:
Running... Show data?	A

Continue Pressing A until

Running... Examine Hardware?	ENT

Once selected, use A key to scroll through the hardware setup.

Use the C key to return to “Show Data?”

8.5 EXAMINE COMPUTATIONS

This feature is used to examine which computation has been selected.

DISPLAY:	PRESS:
Running... Show Data?	A

Continue Pressing A until

Running...
Examine Comps?

Once selected, use ENT key to return to “Show Data?”

8.6 EXAMINE VARIABLES

This feature is used to examine the various parameters and constants that have been entered.

DISPLAY:	PRESS:
Running... Show Data?	A

Continue Pressing A until

Running... Examine Variables?	ENT

Once selected, use A and B keys to scroll through the parameters setup.

Use the C or ENT key to return to “Show Data?”

8.7 CHECK ALARM

Press [A]

Running...
Show Data?

[A]

Running...
Go to Standby?

[A]

Running...
Setup data display?

[A]

Running...
Setup print list?

[A]

Running...
Print system setup?

[A]

Running...
Clear Totalizer?

[A]

Running...
Examine Hardware?

[A]

Running...
Examine Comps?

[A]

Running...
Examine Variables?

[A]

Running...
Check Alarm?

[ENT]

Alarm Condition
Press [ENT] to quiet

The most recent alarm condition will be displayed on the top line. Press [ENT] to de-Energize the corresponding alarm relay. If the condition that caused the alarm still exists, the alarm will again energize.

Alarm Condition
Alarm Cleared

Momentarily displayed to indicate that the alarm has been cleared.

Running...
Show Data?

The unit will automatically advance to the top of the "Running" menu. This procedure must be repeated until "No Alarm Condition" is displayed.

8.8 LOCK/UNLOCK

Lock is used in the "Running" mode to prevent unwanted changes in the programming. Lock prevents crossover to the "Setup" mode and the totalizer can not be reset to zero. All other functions in "Running" mode remain operable.

NOTE: Any 5 digit security code (except 00000) may be used to lock the unit. The same 5 digit code must be entered to unlock the unit. Place the 5 digit security code used to lock the unit in a safe location for future reference.

To Lock:

Advance or Backup the menu until the display indicates:

Running... Lock/Unlock?	Press ENT
Machine is unlocked Enter code:	Enter a 5 digit code number (NOTE: Code may NOT be 00000). As each digit is pressed an "*" will appear on the display to verify that the digit has been entered.
Machine is unlocked Enter code: *****	As soon as the fifth digit is entered, 5 "*"s will be displayed momentarily. The unit will then advance to "Now confirm:"
Machine is unlocked Now confirm:	Enter the 5 digit code again
Machine is unlocked Now confirm: *****	As soon as the fifth digit is entered, 5 "8"s will be displayed momentarily. The unit will lock and then advance to the next menu item.
Running... Show Data?	

After the unit is locked, any attempt to "Go to Standby?" (crossover to the "Setup" menu) or to "Clear Totalizer" will result in the following display:

****Locked!!****
Push ENT to continue

All other functions of the "Running" mode remain accessible.

To Unlock:

Advance or Backup the menu until the display indicates:

Running... Lock/Unlock?	Press ENT
Machine is locked Enter code:	Enter the 5 digit code number. No confirming step is required to unlock the unit.
Machine is locked Enter code: *****	The unit will unlock and then advance to the next menu item as soon as the correct code is entered.
Running... Show Data?	

Note: Bad lock code Push ENT to continue	This error message may display after the entry of the 5 digit code in the lock/unlock procedure. Pressing enter will exit the Lock/Unlock menu option and advance to the next menu item.

PRINCIPLES OF OPERATION

9.1 GENERAL

This chapter explains in detail how the instrument calculates the mass flow based on specific data input.

Each parameter is updated at a 2Hz rate. Therefore, all references to the machine's "interval" in the following descriptions indicates a period of 0.4 seconds.

9.2 TEMPERATURE CALCULATIONS

If an RTD is used as a temperature transducer, the computer runs a constant current through both the RTD and the internal semi-precision resistor in series with it. (See section 1.52) The computer measures the voltage drop across each individually and calculates a ratio; thus, determining the actual resistance of the RTD. A look-up table is used to linearize and convert the ohmic reading to temperature in degrees. This value is checked against keyed in alarm limits and the alarm relay is activated if necessary.

Any other type of temperature transducer must present a voltage or current to Channel 1 of the computer. This value is checked against a keyed in temperature parameters to calculate the actual temperature.

9.3 PRESSURE CALCULATIONS

Any pressure transducer must present a voltage or current to Channel 2 of the computer. The raw pressure value is digitized from Channel 2 and then scaled according to the two keyed in pressure parameters to calculate the actual pressure. The value is checked against keyed in alarm limits and the alarm relay is activated if necessary.

9.4 FLOW CALCULATIONS

The value provided by the digital input pulse accumulator is divided by the K-Factor to find the instantaneous flow over the interval. The result is then filtered according to the keyed in flow filter parameter to get uncompensated flow.

The following definitions and calculations are used to determine Volumetric, Mass and Heat Flow.

Definition of Terms:

BR:	Base Reference Temperature entered by user.
c:	Thermal coefficient of expansion for the media (X 10^{-6}).
DENSITY:	Density as calculated from parameters and inputs.
DP:	Differential pressure in inches of water calculated from flow input.
FLOW:	Uncompensated flow calculated from input.
HZ:	Input frequency in cycles per seconds.
K:	The meter calibration factor in pulses per cubic foot or gallon.
K1:	Factor used in Orifice/Pitot calculations.
kPa:	The absolute pressure (Gage pressure + Barometric pressure).
MASS:	Mass flow rate calculated using temperature, pressure and flow. Del Heat equation uses temp 1 for Mass calculations.
PSIA:	The absolute pressure (Gage pressure + Barometric pressure).
PSIG:	Upstream gage pressure calculated from input.
SG:	Specific Gravity as entered by user with respect to Standard conditions or the Base Reference temperature.
SH:	Specific Heat as entered by user or from Steam Tables.
SV:	Specific Volume from Steam Tables.
TEMP:	Temperature as calculated from input.
UCFLOW:	Uncompensated flow as determined by calculations.
VOL:	Volumetric flow as determined by calculations.
Z:	Gas compressibility factor as entered by user.
%:	Percentage as a decimal point of full scale of the raw input.

FLOW INPUT CALCULATIONS:

Digital:
(Hz/K) x (60 sec/1 min) = UCFLOW

Analog-Linear:
Lo-Flow + (Hi Flow – Lo Flow) x (%) = UCFLOW

Analog-Orifice/Pitot:
Delta P lo + (Delta P hi – Delta P lo) x (%) = DP

DENSITY CALCULATIONS:

Density-Liquid:
SG x 62.3663 = DENSITY (Metric: SG x 62.42797 = DENISTY)

Density-Steam:
1/SV = DENSITY

Density-Gas English:
(2.698825 x SG x PSIA)/(Z x TEMP + 459.67) = DENSITY

Density-Gas Metric:
(3.483407 x SG x kPa)/(Z x TEMP + 273.15) = DENSITY

Orifice/Pitot Calculation English:
$K1 \times \sqrt{DP/(DENSITY \times 0.3705316202)} = UCFLOW$ (in ACFM)

Orifice/Pitot Calculation Metric
$K1 \times \sqrt{DP/(DENSITY \times 0.287075)} = UCFLOW$ (in m^3/h)

VOLUMETRIC FLOW CALCULATIONS:

Gas English:
(PSIA/14.696) x (519.67/TEMP + 459.67) x (1/Z) x UCFLOW) = VOL

Gas Metric:
(PSIA/14.696) x (273.15/TEMP + 273.15) x (1/Z) x UCFLOW) = VOL

Liquid:
UCFLOW x [1-C x (TEMP – BR)] = VOL

MASS FLOW CALCULATIONS:

Gas/Steam:
UCFLOW x DENSITY = MASS

Liquids English:
$[1-C \times (TEMP - BR)]^2 \times DENSITY \times UCFLOW = MASS$

Liquids Metric:
$[1-C \times (TEMP - BR)]^2 \times DENSITY \times UCFLOW = MASS$

HEAT FLOW CALCULATIONS:

Gas/Liquid:
MASS x SH x (TEMP + 459.67) = Heat

Steam:
SH x MASS = HEAT

Del Heat Liquid:
$MASS \times SH \times (TEMP_1 - TEMP_2) = HEAT$

Appendix i

OPERATING PARAMETERS

INPUT FLOW PARAMETERS

PARAMETERS:	DEFAULT: English	ENGLISH:	METRIC: (kPa)	METRIC: (kg/cm^2)	METRIC: (bars)	NOTES:
K Factor	null	Pulses/unit volume				Digital Only
Z Factor	null	Gas Compressibility				Gas
Specific Gravity	null	Dimensionless				Mass/Heat
K1 Factor	null	As needed				Orifice/Pitot
Low Flow	null	Cu ft/min	m^3/h	m^3/h	m^3/h	Linear Gas
Hi Flow	null	Cu ft/min	m^3/h	m^3/h	m^3/h	Linear Gas
Lo Cutoff	0.0	Cu ft/min	m^3/h	m^3/h	m^3/h	All Gas
Low Flow	null	GPM	Liter/s	Liter/s	Liter/s	Linear Liquid
Hi Flow	null	GPM	Liter/s	Liter/s	Liter/s	Linear Liquid
Lo Cutoff	0.0	GPM	Liter/s	Liter/s	Liter/s	All Liquid
Delta P lo	null	In of Water	mmW.C.	mmW.C.	mmW.C.	Orifice/Pitot
Delta P Hi	null	In of Water	mmW.C.	mmW.C.	mmW.C.	Orifice/Pitot
Input Filter	40000.0	Hertz	Hertz	Hertz	Hertz	Digital Only
C Factor (x 10^{-6})	null	Dimensionless				Liquid Mass
Mean Specific Heat	null	Btu/lbm-mol-^oR	Wh/kg-mol-^oK	Wh/kg-mol-^oK	Wh/kg-mol-^oK	Heat
Low Alarm	0.0	Cu ft/min	m^3/h	m^3/h	m^3/h	All
Hi Alarm	99999	Cu ft/min	m^3/h	m^3/h	m^3/h	All

TEMPERATURE PARAMETERS

PARAMETER:	DEFAULT:	ENGLISH:	METRIC: (kPa)	METRIC: (kg/cm^2)	METRIC: (bars)	NOTES:
Low Temp	null	Degrees F	Degrees C	Degrees C	Degrees C	All but RTD
High Temp	null	Degrees F	Degrees C	Degrees C	Degrees C	All but RTD
Base Reference Temp.	60.0	Degrees F	Degrees C	Degrees C	Degrees C	Liquid Mass
Low Alarm	0.0	Degrees F	Degrees C	Degrees C	Degrees C	All
High Alarm	850.0	Degrees F	Degrees C	Degrees C	Degrees C	All

PRESSURE PARAMETERS

PARAMETER:	DEFAULT:	ENGLISH:	METRIC: (kPa)	METRIC: (kg/cm^2)	METRIC: (bars)	NOTES:
Low Pressure	0.0	PSIG	kPa	kg/cm^2	bar	All
High Pressure	0.0	PSIG	kPa	kg/cm^2	bar	All
Barom. Pressure	14.696	PSIA	kPa	kg/cm^2	bar	All
Low Alarm	0.0	PSIG	kPa	kg/cm^2	bar	All
High Alarm	25000	PSIG	kPa	kg/cm^2	bar	All

OUTPUT FLOW PARAMETERS

PARAMETER:	DEFAULT:	ENGLISH:	METRIC: (kPa)	METRIC: (kg/cm^2)	METRIC: (bars)	NOTES:
Minimum Flow	null	units of flow/time at 4mA				All
Maximum Flow	null	units of flow/time at 20mA				All
Scaling	null	Pulses x compensated units of flow				All

SERIAL COMMUNICATIONS PARAMETERS

PARAMETER:	DEFAULT:	ENGLISH:	METRIC: (kPa)	METRIC: (kg/cm^2)	METRIC: (bars)	NOTES:
Unit ID	1.0	Dimensionless				All
Baud Rate	9600	Bits/sec	Bits/sec	Bits/sec	Bits/sec	All
Print Interval	0.000	minutes	minutes	minutes	minutes	All
On/Off Line	off	Logic	Logic	Logic	Logic	All
Exception Reporting	off	Logic	Logic	Logic	Logic	All

OUTPUT PARAMETERS

PARAMETERS	**NOTES:**	**ENGLISH**	**METRIC:**	**METRIC:**	**METRIC:**
			(kPa)	(kg/cm^2)	(bars)
Time and Date	All	Hr:Min;sec Day, Month Date, Year			
Flow rate	Gas	SCFM	m^3/h	m^3/h	m^3/h
Flow Rate	Liquid	GPM	liters/sec	liters/sec	liters/sec
Mass Flow	All	lbm/h			
Heat Flow	All	Btu/h			
Totalizer	Liquid (Vol)	Gals			
Totalizer	Gas (Vol)	Cu ft			
Totalizer	Mass	lbm			
Heat Totalizer	Heat	kBtu			
Temperature	All	Deg F			
Temperature 2	All	Deg F			
Delta Temperature	All	Deg F			
Pressure	All	PSIG			
Uncompensated Flow	All	ACFM			
Raw Flow (Chan 3)	Analog Flow Input	Volts, mA	Volts, mA	Volts, mA	Volts, mA
Raw Temp (Chan 1)	All but RTD	Volts, mA	Volts, mA	Volts, mA	Volts, mA
Raw RTD input	RTD only	mA	mA	mA	mA
RTD ohms	RTD only	Ohms	Ohms	Ohms	Ohms
Raw Press (Chan 2)	All	Volts, mA	Volts, mA	Volts, mA	Volts, mA
Raw Temp (Chan 2)	All but RTD	Volts, mA	Volts, mA	Volts, mA	Volts, mA
Raw RTD Input 2	RTD only	mA	mA	mA	mA
RTD ohms (Chan 2)	RTD only	Ohms	Ohms	Ohms	Ohms
Analog Output	All	mA	mA	mA	mA
Flow Frequency	All	Hz	Hz	Hz	Hz
Specific Volume	Steam	Cu ft/lbm	m^3/m	m^3/m	m^3/m
Specific Heat	Heat Steam	Btu^{o}F/lbm	kcal^{o}C/kg	kcal^{o}C/kg	kcal^{o}C/kg

Appendix ii

CONVERSION TABLE

Convert from:

ENGLISH	X	(CONVERSION FACTOR)	=	METRIC
ft^3/min	X	1.69902	=	m^3/h
GPM	X	0.063085	=	liters/sec
lbm/h	X	0.45359	=	kg/h
Btu/h	X	0.01757	=	kW
Btu/h	X	15.12	=	kcal/h
Btu/h	X	0.0633034	=	MJ/h
ft^3	X	0.028317	=	m^3
gals	X	3.785109	=	liters
lbm	X	0.45359	=	kg
Btu	X	0.0002928	=	kWh
Btu	X	0.252	=	kcal
Btu	X	0.001055056	=	MJ
Deg F	X	(0.555555) + (-17.7776)	=	Deg C
PSIG	X	6.894757	=	kPa
PSIG	X	0.070306	=	kg/cm^2
PSIG	X	0.06894757	=	bar
GPM	X	0.01337	=	ACFM
ACFM	X	7.4805	=	GPM

Appendix iii

PROGRAMMING ERROR MESSAGES

These messages occur when attempting to go to the running mode or entering a value that is not allowed.

NOTE: All Error messages are followed by the phrase: "Push ENT to continue" Pressing ENT does not correct the error nor access the point of error. The menu must be accessed and correct data entered.

MESSAGES

TEMP HI-LO LIM ERR:	Temperature input parameters have not been entered or a low limit is higher than a high limit.
PRESS HI-LO LIM ERR:	Pressure input parameters have not been entered or a low limit is higher than a high limit.
FLOW HI-LO LIM ERR:	Flow input parameters have not been entered or a low limit is higher than a high limit.
NEED MORE FLOW INFO:	All of the flow input parameters have not been entered.
Z FACTOR ERROR:	Z factor has been set to zero; change to any number greater than zero.
SCALE FACTOR ERROR:	K factor has been set to zero; change to any number greater than zero.
NO VALUE STORED YET:	The unit has a null value in it from initialization. Enter a value.
BAD LOCK CODE:	Attempt has been made to enter 00000 as the lockout code; use any number other than 00000 to lock out computer. In the lock confirming step, the 5 digit code entered is not the same as the 5 digits initially entered.
SYNTAX ERROR:	Time or date was not entered in proper format. Refer to section 7.
BAD TIME VALUE:	Invalid time entered. Refer to section 7.
BAD DATE VALUE:	Invalid date entered. Refer to section 7.
BAD ID VALUE:	RS-232 option only. Invalid unit ID entered. Refer to RS-232 instructions.

Appendix iv

ALARM MESSAGES

NOTE: All alarm messages are followed by the phrase “Press ENT to quiet”. This will clear the alarm only. If the alarm condition is still present, the alarm relay will pull in again.

MESSAGES

PRESS TOO LOW:	Gage pressure has gone below the Lo alarm value set in the variables.
PRESS TOO HI:	Gage pressure has gone above the Hi alarm value set in the variables.
TEMP TOO LOW:	Temperature has gone below the Lo alarm value set in the variables.
TEMP TOO HI:	Temperature has gone above the Hi alarm value set in the variables.
INSUFFICIENT FLOW:	Compensated flow has gone below the Lo alarm value set in the variables.
EXCESSIVE FLOW:	Compensated flow has gone above the Hi alarm value set in the variables.
ANALOG OUT ERROR:	4-20mA output is broken or Compensated flow has exceeded the 20mA value set in the variables.
4-20Ma LOOP BROKEN:	One of the 4-20mA input loops is broken.
OFF STEAM TABLES:	Temperature or pressure inputs have gone below or exceeded the range of the Flow Computer’s internal steam tables.
WET STEAM CONDITION:	Typically a delayed alarm. Alarm occurs if condition persists for longer than two minutes. Temperature or pressure inputs have gone below the saturated steam range of the Flow Computer’s internal steam tables.

Appendix v Troubleshooting Guide

OPERATOR FORGETS SECURITY LOCKOUT CODE

If the authorized programmer of the instrument forgets the security code and is locked out, follow this procedure:

A. Scroll through the menu to the Lock/Unlock menu. Press the [ENT] key.
B. At the prompt, enter the code 00000 using the keypad.
C. The instrument will display a message “CALL IN CODE” and a 5-digit number.
D. Call the manufacturer and ask for the proper Customer Service Personnel.
E. Customer Service will ask for a 5 digit CALL IN CODE and will give back a 50digit RETURN CODE that was generated by a computer.
F. Enter this 5 digit RETURN CODE using the keypad.
G. Five chances to enter the RETURN CODE are allowed, after which this procedure will have to be repeated.
H. Once the new 5 digit code has been successfully entered, it will unlock the Flow Computer.
I. It is the programmer’s responsibility to reset the instrument with a new 5 digit lockout code.
J. If, at a later date, you are locked out of the instrument again, you will have to call and repeat this procedure. A new CALL IN CODE will be generated by the instrument.

PULSE INPUTS ARE NOT COUNTING ON THE INSTRUMENT

A. Check the voltage of the pulses. They must be between 3-30V, and not less than 3V or negative.
B. Check pulse width. The pulse width of the signal must be consistent with the filter that you have selected. If this is not the case, change the filter value.

INSTRUMENT NEEDS TO BE TOTALLY RE-INITIALIZED TO CLEAR OUT THE MEMORY

Power up the instrument and press the [A] and the [CLR] keys at the same time. This will totally re-initialize the instrument. All parameters will be reset to their default values. The unit will require you to input the parameters that have null values and select the various options available.

RS-232 OPERATING INSTRUCTIONS

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RS-232 OPERATING INSTRUCTIONS

GENERAL

This chapter summarizes operation of the SP3000 MASS FLOW COMPUTER with a remote terminal. It is recommended that you read the preceding chapters of the Operating Instructions. You should be familiar with the format and methods used in setting up the basic instrument before using the RS-232 communications option.

Setting up the RS-232 Link

The RS-232 connector is a standard 25 pin connector, and it is located at the rear of the instrument. Figure 1 shows a wiring diagram for the Sub-D 25 Pin connector. Standard inputs must present a load of 3000 to 7000 Ohms. A voltage level of +3V to +25V (reference to signal ground) is read as a "Space" or "0" and indicates an active state (does not assert a control line). Outputs must send a voltage of +15V to +25V (reference to signal ground) for a "Space" and a voltage of -5V to -25V for a "Mark" when loaded with a 3000 Ohm load to signal ground. Outputs must be capable of being shorted to other signal lines without burning out. It is normally recommended that cable length be limited to 50 feet.

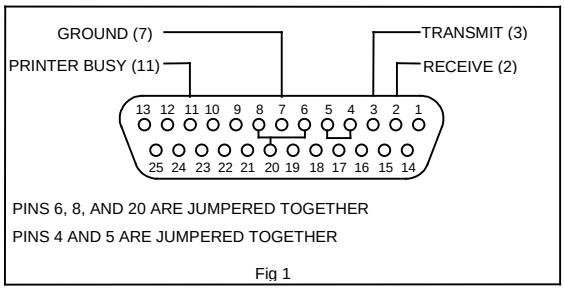


Fig 1

Activating the Printer Busy Line on the SP3000

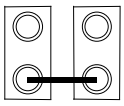
Two jumpers are needed to activate the printhead busy option on the RS-232 card. These jumpers are located on the RS-232 card to the left of the 25 pin connector (looking from the back).

If Jumper 1 (JP1) is connected, the handshake option is activated. The handshake line is Pin #11 on the RS-232 25 pin connector. Refer to Fig. 2 below.

Jumper 2 (JP2) determines whether Pin #11 is high or low when the printhead is busy. If (JP2) is installed, then Pin #11 goes high when the printhead is busy. Refer to Fig. 3 below.

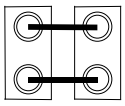
Be sure to follow case disassembly and other handling procedures outlined in this manual.

Fig 2



Connect JP1 to activate option

Fig 3



Connect JP2 to indicate that the printhead is busy when Pin #11 is high

Line Oriented Data Input

RS-232 communication provides access to all operating parameters of the Flow Computer. The instrument constantly monitors the RS-232 port for activity, entering the data received into an internal 80 character memory buffer. Entry is terminated when a carriage return is entered (Return or Enter key) or when the buffer size is exceeded. At that time, the information is parsed by the internal parser and a dispatch to the appropriate service routine is made.

Parser

Because so much information must be typed to communicate with the instrument, a sophisticated parser has been included to facilitate this data entry. It is very forgiving of typing mistakes. When a command is typed, the parser finds the closest match between what is typed and the keypads stored in its memory. This memory of "parsing to uniqueness" requires only enough information in the keyword to be able to distinguish it from the other words.

When a phrase is required to indicate a specific variable, the order of the words contained in the phrase will not matter. Also, unnecessary words will not cause an error in phrases which may contain related but unnecessary words.

If a phrase cannot be understood or is ambiguous, the instrument will ignore the command and an error message will be displayed. If possible, the instrument will indicate problem areas to assist in accurate data entry on the next try.

Line Editing:

Rudimentary line editing is accomplished by using the backspace key, which will erase the previous character, and the Control-U and Control-C keys, will erase the entire line.

Protocol:

The instrument operates at 300, 1200, or 9600 baud, with 8 bits, 1 stop bit, and no parity. The remote terminal or computer should be configured appropriately.

Getting started:

The baud rate and the unit identification number must be set up via the front keypad on the SP3000.

In the Setup Mode:
Press [A] until

Sponsler V6.13 MS197
Serial Interface?
[ENT]

Serial Interface
Unit ID?
[ENT]

1-99
Unit ID?

Enter the required unit identification number (1-99)
Press [ENT]
NOTE: An invalid ID number entry will force an error message: Bad ID Value
Push [ENT] to continue

Serial Interface
Baud Rate?

Select Baud Rate: 9600?	Press A or B to advance or back up the sub-menu: 9600? 1200? 300? When desired baud rate is displayed, Press ENT
Serial Interface: Print Interval? ENT	
(In Minutes) Print Intvl?	Enter the time in minutes required between printouts NOTE: The minimum print interval is 0.25 minutes. Any value less than 0.25 will inhibit the serial output of the list that is established in the "Running" menu Press ENT
Serial Interface On/Off Line? ENT	
On/Off Line Off? A	Select option to activate the serial port. Press ENT
On/Off Line On?	
Serial Interface: Exception Reporting? ENT	
Exception Reporting Off? A	Select option to print out alarm conditions Press ENT
Exception reporting On?	
Sponsler V6.13 MS197 Serial Interface?	The unit returns to this menu item as it is the last item. Press C to return to Run? option.

Once these parameters have been set, two-way RS-232 communications may be used.

Throughout the text there are references to other sections of the Manual for additional information and clarification.

COMMAND CATEGORIES:

Command Keywords:	
SET	Sets variables & parameters
EXAMINE	Examines variables & parameters
RUN	Start the instrument
STOP	Stop the instrument
CLEAR	Alarm or Totalizer
LOCK	Locks instrument
UNLOCK	Unlocks instrument
SYSDUMP	Show everything
"X" Command	Shows specific piece of information

SET COMMANDS:

SET COMMANDS allow functions to be set remotely.

SET COMPUTATIONS -	Sets the computations that will be used for Volume, Mass, or Heat Flow
SET UNITS -	Sets engineering units of the instrument to English or Metric.
SET HARDWARE -	Sets specific hardware parameters of the instrument.
SET TIME -	Sets the internal real time clock.
SET DATE -	Sets the internal date of the instrument.
SET LIST -	Sets up the list of calculated values that will be printed through the serial port while running.
SET EXCEPTION -	Turns exception reporting ON or OFF.

SET COMPUTATIONS

Reference: See Section 3.2
Format: SET COMPUTATIONS [text] (CR)
Function: Computation units set depending on text string:

REQUIRED TEXT	
VOLUME	(Ideal Gas-Volume)
MASS	(Ideal Gas-Mass)
STEAM	(Steam Tables- Mass)
LIQMASS	(Liquids- Mass)
LIQVOL	(Liquids- Volume)
HEATGAS	(Heat- Gas)
HEATSTEAM	(Heat- Steam)
HEATLIQUID	(Heat- Liquid)
DEL HEAT	(Del Heat- Liquids)

Example: SET COMPUTATIONS HEATSTEAM (CR)

SET UNITS

Reference: See Section 3.4
Format: SET HARDWARE [text] (CR)
Function: The SET HARDWARE command parallels the Hardware Setup menu. The user may configure the input hardware using this command.

The command consists of the word SET HARDWARE, followed by the word FLOW, TEMPERATURE, or PRESSURE, and then by the input characteristics desired. Key input characteristics are 5V, 10V, 4-20mA, 0-20mA, RTD, and DIGITAL.

Note that RTD may be used only on temperature input, and DIGITAL may be used only on the flow input.

When configuring the flow channel, the (optional) final word is used to indicate the type of meter being used, and may be either LINEAR or ORIFICE/PITOT, as required. If this qualifier is omitted, the type is not changed.

EXAMPLES:

SET HARDWARE Pressure 10V	(CR)
SET HARDWARE Temperature 4mA	(CR)
SET HARDWARE Flow Digital	(CR)
SET HARDWARE Flow 4-20 Orifice	(CR)

SPECIFIC PARAMETERS SET COMMANDS

Function: The SET command can also be used to set miscellaneous parameters in the instrument. With a SET command, a numerical argument must follow.

USING THE SET COMMAND:

To set one of the instrument's preset variables, the instrument will parse the phrase following the word SET to find the specific preset variable to access.

Certain keywords are required to uniquely identify a variable:

FLOW	FACTOR	OUTPUT
TEMPERATURE	ALARM	HIGH
PRESSURE	LIMIT	LOW
SCALE	INPUT	FILTER

The phrase must be followed by a decimal number of an appropriate value.

Examples of legitimate SET phrases are as follows:

SET K factor to 1.0123	(CR)
SET flow low input scale to 0	(CR)
SET flow hi input scale to 100	(CR)
SET flow low alarm to 0	(CR)
SET flow hi alarm to 1000.0	(CR)
SET low temperature scale input to –10	(CR)
SET hi scale input of temperature to 100	(CR)
SET output digital scaling at 10	(CR)

NOTE: (CR) indicates the ENTER or RETURN key of the terminal.

After each successfully parsed phrase, the instrument will immediately show the variable that has been changed and the new value to which it has been set.

If a phrase cannot be understood or is ambiguous, the unit will give an error message.
For example:

SET flow temperature to 12 (CR)

The instrument will not understand this command and will give a “Syntax Error” message. The problem with this command is that it does not specify to setup alarm or scale.

A more subtle type of problem with a command is as follows:

SET flow alarm to 100 (CR)

This phrase will also generate a “Syntax Error” because it is unclear whether the LOW flow alarm or the HIGH flow alarm is to be accessed.

Reference: See Section 3.5

REQUIRED WORDS:	**OPTIONAL WORDS:**
SET temperature low scale	input
SET temperature high scale	input
SET reference temperature	
SET temperature low alarm	
SET temperature high alarm	
SET pressure low scale	input
SET pressure high scale	input
SET barometric	pressure
SET pressure low alarm	
SET pressure high alarm	
SET k	factor
SET k1	factor
SET z	factor
SET gravity	specific
SET c	thermal expansion
SET heat	specific

SET point
This command is followed by three numbers. The point number, the uncompensated flow (pulse or analog) and then the K factor.

SET flow low scale	input
SET flow high scale	input
SET delta P high	input
SET delta P low	input
SET flow cutoff	low
SET flow filter	input
SET flow low alarm	
SET flow high alarm	
SET low output	flow scale
SET high output	flow scale
SET scale output	flow digital factor pulse

SET id (See special section on SET ID; pg. 7)
SET baud (See special section on SET BAUD; pg. 7)
SET print interval

In addition to the optional words listed above, the words “to”, “of”, and “limit” are allowed in any phrase (in the context of the SET command) and are always ignored.

SET TIME:

Reference: See Section 7
Format: : SET TIME [hh:mm] (CR)
Function: Sets the Real time clock in the instrument to time (hh:mm) where
hh indicates hours (00-23)
mm indicates minutes (00-59)
NOTE: 24 hour format must be used.

Example: SET TIME 12:42 (CR)

SET DATE:

Reference: See Section 7
Format: : SET DATE [mm/dd/yy] (CR)
Function: Sets the Real time clock on the instrument to date mm/dd/yy where
mm indicates month (1-12)
dd indicates day (1-31)
yy indicates year (0-99)

Year numbers 88 through 99 indicate 1988 through 1999, 00 through 87 indicate 2000 through 2087
If desired, the year may be explicitly entered as 1992, for example.

Upon entry, the date is evaluated and rejected if illogical (Feb 29, 1989 would be rejected, for example)

Example: SET DATE 04.28.92 (CR)

SET ID:

Format:: SET ID [nn] (CR)
where nn is a number from 1-99
Function: Sets the device ID of the instrument to the number nn specified. If different from the current ID, the instrument is immediately deselected. You must type Dnn to bring it back online.

The unit is selected using a selection code beginning with the letter D followed immediately by a one or two digit code in the range of 0-99. Further extraneous information entered on the line is ignored. The first serial command sent to it should be Dnn to bring it online. Initially, and when the instrument is reinitialized, it defaults to Device #1. The next return character sent to the control will enable it as indicated by the MFCnn prompt, where nn indicates the device ID. When the instrument is powered up, it is deselected and must be enabled to communicate.

NOTE: Although there are up to 99 different ID numbers, this does not mean that 99 can be driven off one line. The maximum number of units on a single RS-232 line is 20.

Example: SET ID 01 (CR)

SET BAUD

Format:: SET BAUD [nnnn] (CR)
Function: Sets the baud rate to the value specified in nnnn. nnnn may be 300, 1200, or 9600. The baud rate is immediately set to the value specified.
NOTE: 300 baud may cause undesirable delays in communication.

Example: SET BAUD 1200 (CR)

SET EXCEPTION:

Format:: SET EXCEPTION [ON, OFF] (CR)
Function: Turns Exception Reporting ON or OFF.

Exception Reporting is a function that allows the operator to view different parameters that have recently gone into alarm condition (See section on Exception Reporting in this chapter).

Example: SET EXCEPTION on (CR)

SET LIST:

Reference: See Section 8.2
Format:: SET LIST n n n n (CR)
Where n is the number of an item on the display list
Function: The SET LIST command is used to set up a display list which can be periodically printed at a remote terminal or printer. The user would first type EXAMINE LIST to obtain a list of available display items, and would then use the SET LIST command to enter them into a printable list of items.

Example: MFC01 Examine List (CR)
[SELECT items from this list:]

[1] Time & Date
[2] Flow rate
[3] Totalizer
[4] Temperature
[5] Pressure
[6] Uncompensated Flow
[7] Raw Flow (Chan 3)
[8] Raw Temp. (Chan 1)
[9] Raw Press. (Chan 2)
[10] Analog Output
MFC01

NOTE: List will vary depending on Hardware and Computation Selected.

Then, the user selects time, flow rate, totalizer, and pressure by typing:
MFC01 SET LIST 1 2 3 5 (CR)
Then when the instrument is running and the PRINT INTERVAL is greater than 0.24999 minutes the instrument will show:

11:55:52 Monday	April 28, 1992
Flow Rate	10,000 SCFM
Totalizer	1245.000 cu-ft
Pressure	12.000 PSIG

EXAMINE COMMAND:

Reference: See Section 8.4 through 8.6
Function: The EXAMINE commands are used to examine setup information about the instrument.

EXAMINE COMPUTATIONS
EXAMINEs if computations that will be used have been set for Volume, Mass, or Heat for Gas, Liquid, or Steam.

EXAMINE UNITS
EXAMINEs which engineering unit has been selected (English or Metric)

EXAMINE HARDWARE
EXAMINEs specific hardware settings of the instrument, and tells if instrument is locked or unlocked.

SPECIFIC EXAMINE COMMANDS

In addition to the EXAMINE Commands listed previously, there are SPECIFIC EXAMINE COMMANDS that allow specific parameters to be EXAMINEd remotely.

REQUIRED WORDS:	OPTIONAL WORDS:
EXAMINE temperature low scale	input
EXAMINE temperature high scale	input
EXAMINE reference temperature	
EXAMINE temperature low alarm	
EXAMINE temperature high alarm	
EXAMINE pressure low scale	input
EXAMINE pressure high scale	input
EXAMINE barometric	pressure
EXAMINE pressure low alarm	
EXAMINE pressure high alarm	
EXAMINE k	factor
EXAMINE k1	factor
EXAMINE z	factor
EXAMINE gravity	specific
EXAMINE c	thermal expansion
EXAMINE heat	specific
EXAMINE point	
EXAMINE flow low scale	input
EXAMINE flow high scale	input
EXAMINE delta P high	input
EXAMINE delta P low	input
EXAMINE flow cutoff	
EXAMINE flow filter	
EXAMINE flow low alarm	
EXAMINE flow high alarm	

EXAMINE low output
EXAMINE high output
EXAMINE scale output

EXAMINE ALARM
EXAMINEs current alarm condition

EXAMINE TIME
EXAMINEs real time clock's time

EXAMINE DATE
EXAMINEs real time clock's date

EXAMINE SERIAL
EXAMINEs the setting of the instrument for ID number, Baud Rate, and Print Interval

EXAMINE EXCEPTION
EXAMINEs if Exception Reporting if turned ON or OFF

EXAMINE RESULTS
EXAMINEs all items on the display list

EXAMINE LIST
EXAMINEs the list of parameters that will be printed during operations.

RUN COMMAND

Reference: See Section 3.0
Function: Starts the instrument running, just like "RUN" on the main menu. Display reads: Show Data? Optionally "GO" may be used in the same capacity.
Example: RUN (CR)

STOP COMMAND

Function: Stops the instrument. from. Display reads: Run? Optionally, "Standby" may be used in the same capacity.
Example: Stop (CR)

CLEAR COMMAND

Reference: See Section 4 and 5
Function: Clear Alarm or Clear Totalizer

This command consists of two words, the first being CLEAR and the second being either ALARM or TOTALIZER.

Example: CLEAR Alarm (CR)
CLEAR Totalizer (CR)

LOCK/UNLOCK COMMANDS

Reference: See Section 6
Function: Locks or unlocks the instrument
Format: LOCK [nnnnn] (CR)

The instrument is locked by supplying a 5 digit lock code.

Example: LOCK 12345 (CR)
Format: UNLOCK [nnnnn] (CR)

The instrument is unlocked by supplying the same 5 digit lock code to the instrument.

Example: UNLOCK 12345 (CR)

SYSDUMP COMMAND

Function: The sysdump command is one of the most useful commands. With it, you may obtain a complete snapshot of the current configuration of the instrument including the values stored for all active variables.

Example: SYSDUMP (CR)

X COMMAND

Function: To allow a remote computer to access a specific piece of information, the X command has been provided.
Format:: X [n]
Where n designates the index of the displayed item as shown by the EXAMINE LIST command (See page for more details).

Example: Suppose n=9 corresponded to the displayed ANALOG OUTPUT value. The command X 9 might result in the response:
X 9 (CR)

Terminal Responds: 4.00 mA

EXCEPTION REPORTING

Exception Reporting is used to send out a report whenever an alarm condition is present. As soon as an alarm condition occurs, the unit sends out the following information over the RS-232 lines:

The Unit ID number
The Time and Date
The Alarm Condition(s)

The unit will then send this information out, along with the print list selected, every print interval (of the print interval is greater than 0.24999 minutes).

Each time an alarm condition is corrected, another exception report will be generated stating that the alarm condition is no longer present.

NOTE: Even thought the alarm condition may have been corrected and the report sent out, the alarm relay will NOT shut off until cleared through the front keypad or the RS-232 link.

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