MODEL 2000

FLOW COMPUTER

INSTRUMENT INSTRUCTION MANUAL

Model 2000 iss 15	DM1171	DM1155	DM1138	DM1127	DM1121	DM1113	DM1104	DM1088
202/11-05	01/06/03	21/03/03	24/01/03	16/09/02	03/07/02	28/05/02	05/04/02	04/02/02
V5.00				DM1303	DM1276	DM1260	DM1226	DM1179
				18/11/05	21/06/05	08/02/05	29/04/04	05/09/03

In the design and construction of this equipment and instructions contained in this manual, due consideration has been given to safety requirements in respect of statutory industrial regulations.

Users are reminded that these regulations similarly apply to installation, operation and maintenance, safety being mainly dependent upon the skill of the operator and strict supervisory control.

DECLARATION OF CONFORMITY

We

BS Instruments Ltd.

of

Hawthorn Road
Littlehampton
West Sussex
BN17 7LT
United Kingdom

Declare under our sole responsibility that the product (s)

Model 2000 Flow Computer

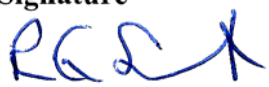
to which this declaration relates is in conformity with the following standards or other normative documents.

EN 50081-1 (1992)
EN 50082-2 (1995)

Date and Place of Issue:-

Littlehampton UK 09-09-2003

R.G. SMITH
Signature



Managing Director
BS Instruments Ltd

CONTENTS Page No.

1.0 INTRODUCTION

SECTION 1

1.0 INTRODUCTION

The INSTROMET Model 2000 Flow Computer is designed to calculate the total energy, volume and instantaneous flow rates of gas and alternatively Liquids. Calculation is carried out using inputs from pulse generating turbine meters or from ultrasonic gas meters or from differential pressure measurement across orifice plates together with temperature sensors and transmitters for line pressure. The Model 2000 uses pre-set or active input values of relative density, gas composition data and heating value, active values can be received directly from a gas chromatograph or can be written serially from a supervisory system.

The flow of gas is calculated using gas compressibility (Z factor) methods selected from a list of which includes AGA 8, ISO 12213 and AGA 3 NX19 as well as fixed factors for certain applications. As an alternative the flow of gas can be calculated using a transducer input for Line density.

The flow of liquid is calculated using fixed or measured factors for density and relative density and correction based upon measured temperature and pressure of the Liquid in accordance with API standard chapters 11.2.1M, 11.2.2M & 12.

The Model 2000 has the facility of both high and low alarms on all active input signals, the alarms can be selected to enable a default value to be used in flow calculation for the parameter in the alarm condition. Indication is given of the time of occurrence and clearance of the alarm state, alarm output signals are also provided.

A feature of the Model 2000 is that it can use digital communication to the differential pressure, pressure and temperature transmitters using the HART protocol eliminating the need for calibration of the Model 2000. This feature also eliminates the errors in flow measurement due to ambient temperature effects on the Model 2000, only the temperature coefficient of the transmitters contribute to the error.

As an alternative the Model 2000 can be operated from transmitters that supply a 4–20mA current output and also direct from a 100 ohm platinum resistance thermometer for temperature measurement, these types of input are measured using analogue inputs and a high resolution A-D converter. The analogue inputs are calibrated using software.

The Model 2000 has two RS232/RS485 serial data outputs which can provide Modbus RTU or ASCII communication protocol for operation with system devices and a serial ASCII protocol compatible with most printers.

To provide maximum security of operating data and flow measurement while maintaining flexibility with the auxiliary functions, the Model 2000 is provided with an edit facility where selected data can be changed while security can be preserved with critical data.

All input and output signals are tested to ensure that they are within the designed operating limits, an alarm display records the time when alarms occur and clear. During an alarm condition the total flows can be selected to be displayed on separate counters.

2.0 GENERAL DESCRIPTION

SECTION 2

2.0 GENERAL DESCRIPTION

The Model 2000 Flow Computer comprises a standard size half width 19 inch rack which contains plug-in printed circuit boards connected to a mother board.

The Model 2000 front panel contains a liquid crystal display, keyboard, display buttons and indicator LED's. The liquid crystal display (LCD) is a graphic dot matrix type which is used to display all of the data entered and flow information. The keyboard is used to select the data to be entered into the Model 2000 memory and select all of the displayed information.

Input and output signals are connected to the Model 2000 by 9 pin D type connectors and plug in terminal blocks located at the rear or the unit. The Model 2000 is operated from a 24Vdc. supply.

The front and rear panel arrangement are shown in figures 1 and 2.

2.1 MODEL 2000 FLOW COMPUTER FACILITIES

2.1.1 FLOW COMPUTER TYPES

The Model 2000 Flow Computer can be configured into the following basic types of measurement device.

a) Turbine Gas 1 Stream, 2 Stream or 3 Stream. t1, t2, t3

Gas flow computer 1, 2 or 3 measurement streams using Turbine or pulse type meters as the primary flow measurement device and Pressure, Temperature and Compressibility for flow correction.

b) Ultrasonic Gas 1 Stream. u1

Gas flow computer 1 measurement stream using an Instromet Ultrasonic meter as the primary flow measurement device (Uniform communication to meter) and Pressure, Temperature and Compressibility for flow correction.

Gas flow computer 1 measurement stream using an ABB (Sick) Totalsonic ultrasonic meter or Panametrics GM868 or Daniel Senior Sonic ultrasonic meter as the primary flow measurement device (Modbus RTU communication to meter) and Pressure, Temperature and Compressibility for flow correction.

c) Ultrasonic Gas 2 Streams or 3 Streams. u2, u3

Gas flow computer 2 or 3 measurement streams using Instromet Ultrasonic meters as the primary flow measurement devices (Modbus RTU multidrop communication to meter) and Pressure, Temperature and Compressibility for flow correction.

Gas flow computer 2 or 3 measurement streams using an ABB (Sick) Totalsonic ultrasonic meter or Panametrics GM868 or Daniel Senior Sonic ultrasonic meter as the primary flow measurement devices (Modbus RTU multidrop communication to meter) and Pressure, Temperature and Compressibility for flow correction.

d) Orifice Gas 1 Stream or 2 Stream. o1

Gas flow computer 1 or 2 measurement streams using Orifice plate measurement as the primary flow measurement device and Pressure, Temperature and Compressibility for flow correction.

e) Turbine Density Gas 1 Stream. td1

Gas flow computer 1 measurement stream using Turbine or pulse type meter as the primary flow measurement device and Density measurement for flow correction.

f) Ultrasonic Density Gas 1 Stream. ud1

Gas flow computer 1 measurement stream using an Instromet Ultrasonic meter as the primary flow measurement device and Density measurement for flow correction.

g) Orifice Density Gas 1 Stream. od1

Gas flow computer 1 measurement stream using Orifice plate measurement as the primary flow measurement device and Density measurement for flow correction.

h) Turbine Liquid 1 Stream, 2 Stream or 3 Stream. lt1, lt2, lt3

Liquid flow computer 1, 2 or 3 measurement streams using Turbine or pulse type meters as the primary flow measurement device and Temperature for flow correction.

i) Turbine Liquid Density 1 Stream. ltd1

Liquid flow computer 1 measurement stream using Turbine or pulse type meters as the primary flow measurement device and Line Density for flow correction.

j) Ultrasonic Liquid 1 Stream. lu1

Liquid flow computer 1 measurement stream using an Instromet Ultrasonic meter as the primary flow measurement device and Temperature for flow correction.

k) Venturi 1 Stream or 2 Stream. vt1, vt2

2.0 GENERAL DESCRIPTION

Steam flow computer 1 or 2 measurement streams using Venturi measurement as the primary flow measurement device and Pressure, Temperature and Compressibility for flow correction. This flow computer is for STEAM measurement only.

l) Station Controller. stn

Device to calculate Station Flow values from up to 5 individual flow computers and to distribute gas data information to those flow computers.

m) Wet Gas Venturi 1 Stream WGV1

Steam flow computer 1 measurement stream using Venturi measurement as the primary flow measurement device and Pressure, Temperature and Compressibility for flow correction. This flow computer is for Wet Gas measurement only.

n) Wet Gas Venturi type 2 flow line Stream WGV21

Flow line Steam flow computer measurement stream using Venturi measurement as the primary flow measurement device Mass flow transmitter incorporating measurements for Differential Pressure, Pressure, Temperature and Compressibility for flow correction. This flow computer is for Wet Gas measurement only.

o) Liquid Coriolis Meter 1 Stream or 2 Stream. lc1, lc2

Liquid flow computer 1 or 2 measurement streams using Micro Motion type Coriolis Meter measurement as the primary flow measurement device and Density measurement device. Optional Pressure and Temperature measurement for flow correction.

The basic type selected must be configured into the M2000 using the set-up software, this will then determine the circuit boards required and inputs and outputs to be configured.

The Model 2000 will calculate the volume of gas or liquids using pre-set or active gas data and active input signals for pressure and temperature and either inputs from pulse generating turbine meters, a high frequency pulse input used for flow calculation and a low (or reference) frequency input from the index or from an Instromet type Ultrasonic gas meter or from the differential pressure measurement across an orifice plate. The function and correction of all types of available input is described in section 2.4 of this manual.

The flows calculated are displayed on the LCD display as a 12 digit number (8 digits- decimal- 4 digits) with the scaling factor, units and symbol.

e.g. +Vn1 = 12345678.1234 X 100 m^3

The scaling factor (symbol twf) is entered via the keyboard.

The Model 2000 can be selected to total the flow on a separate counter when an alarm condition occurs.

2.0 GENERAL DESCRIPTION

2.1.2 FLOW COMPUTER OPERATING MODES

The security, set-up and operational modes of the Model 2000 is initiated by the setting of mode switches located under an access hole on the side of the Model 2000 the access hole is normally covered by a plastic cover and can also be sealed using a self adhesive security label (See figure 16 for details) .

The designation and function of the mode switches is as follows:-

Normal RUN mode:-

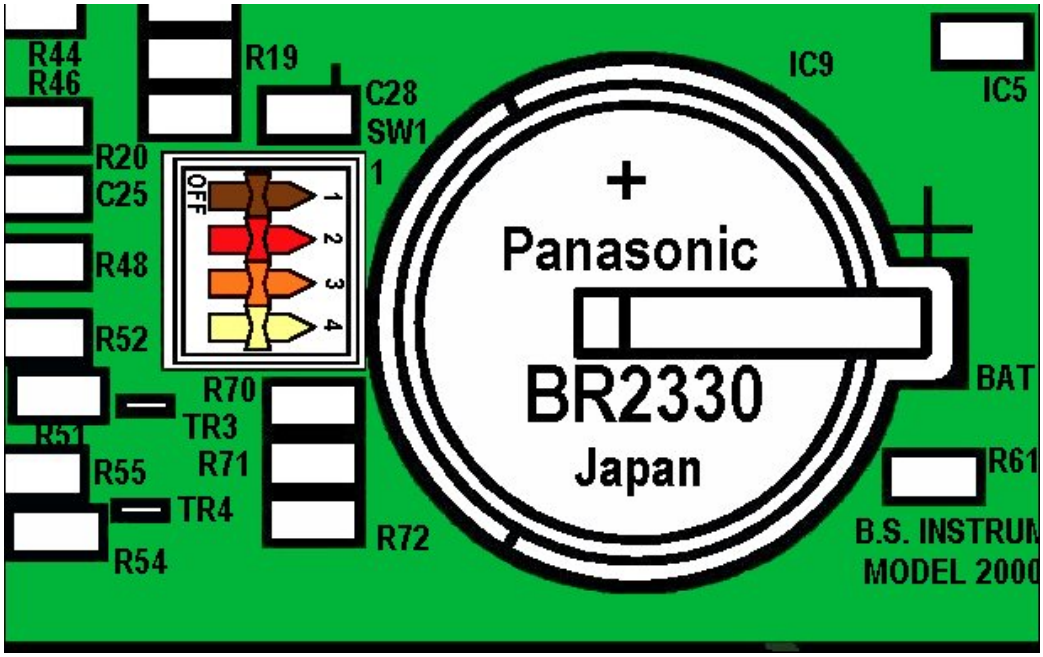
Switch No.	ON	OFF
1	Security 1 Off	Security 1 On
2	Security 2 Off	Security 2 On
3	Run Mode	
4	Backup Battery On	Backup Battery Off

Programming Boot mode

Switch No.	ON	OFF
1	Security 1 Off	Security 1 On
2	Irda Infra Red or Front Panel USB Connector	Rear Connector Skt 1
3		Boot Mode
4	Backup Battery On	Backup Battery Off

2.0 GENERAL DESCRIPTION

View of Microprocessor Board Showing Mode Switches and Backup Battery



To place the Model 2000 in fully secure mode (i.e. no data can be altered either via communication or via the EDIT mode) Mode switches 1 and 2 must be in the OFF position.

To place the Model 2000 in partial secure mode (i.e. selected data can be altered either via communication or via the EDIT mode) one of the security Mode switches must be OFF the other must be ON.

To place the Model 2000 in fully open mode (i.e. all data can be altered either via communication or via the EDIT mode) Mode switches 1 and 2 must be in the ON position.

Mode switch 3 should only be set to the Boot (OFF) position if a new operating programme is going to be downloaded into the machine. In all other modes of operation mode switch 3 must be placed in the run (ON) position.

Mode switch 4 enables the battery backup (ON/OFF) function for shipping, long term storage and transportation this should be set to the OFF position, and should only be set to the ON position immediately prior to operation of the Model 2000.

2.0 GENERAL DESCRIPTION

2.2 FRONT PANEL CONTROLS

All of the controls necessary to operate the Model 2000 are located on the front panel and provide the following functions:-

2.2.1 KEY FUNCTIONS

2.2.1.1 MENU SCROLL UP AND DOWN KEYS

SCROLL UP KEY — Use to move the menu item highlight bar up to the required line of data that is going to be selected.

SCROLL DOWN KEY — Use to move the menu item highlight bar down to the required line of data that is going to be selected.

2.2.1.2 RETURN or ENTER KEY

RETURN or ENTER — The enter key allows the value of data to be entered or highlighted item to be selected. It is generally used when an item of data is to be edited, selected or confirmed.

2.2.1.3 INFORMATION KEY

INFORMATION KEY — The information key can be used to provide additional screen help or information . Whenever the is shown in the display of the Model 2000 this key can be pressed and the additional information will be shown as a help or information box.

2.2.1.4 FUNCTION KEYS

FUNCTION KEYS — The keys shown with the symbols [F1] , [F2] , [F3] & [F4] are the function keys, these keys will have different operating functions depending upon the particular page that is currently in use. The particular function for each individual key is shown directly above each key as a highlighted bar on the Model 2000 display. Note that not function keys will operate on all pages, if a function key has no function then there will be no function indicated above it.

2.2.1.5 EXPONENT KEY

EXPONENT — The exponent key (future use) can be used to exponent type numbers where allowable.
This key currently has no function.

2.2.1.6 NUMERIC KEYS

NUMERIC KEYS — The keys shown with the symbols [1], [2], [3], [4], [5], [6], [7], [8], [9], [0], [.] & [-] can used when entering or editing numeric values into the memory of the model 2000.

2.0 GENERAL DESCRIPTION

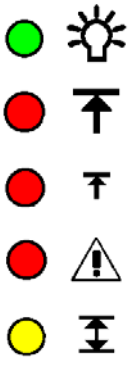
2.2.1.7 PRINTER KEY

PRINTER

The printer key is a shortcut key to the printer function menu, this key will only function if a printer has been set up in the Model 2000 and is functioning correctly. The symbol will appear on the bottom left hand corner of the display if there are printer reports available to be printed.

2.2.2 INDICATOR LEDS

There are five indicator LED's on the Front panel of the Model 2000, from top to bottom these are as shown:-



Power ON	GREEN
Accountable Alarm	RED
Non-accountable Alarm	RED
Fault	RED
Low or High Flow Limit	YELLOW

2.2.3 FRONT PANEL PROGRAMMING PORT

There are two types of Model 2000 Front Panel programming ports both have exactly the same function they differ in the method of connection from a PC to the Model 2000.

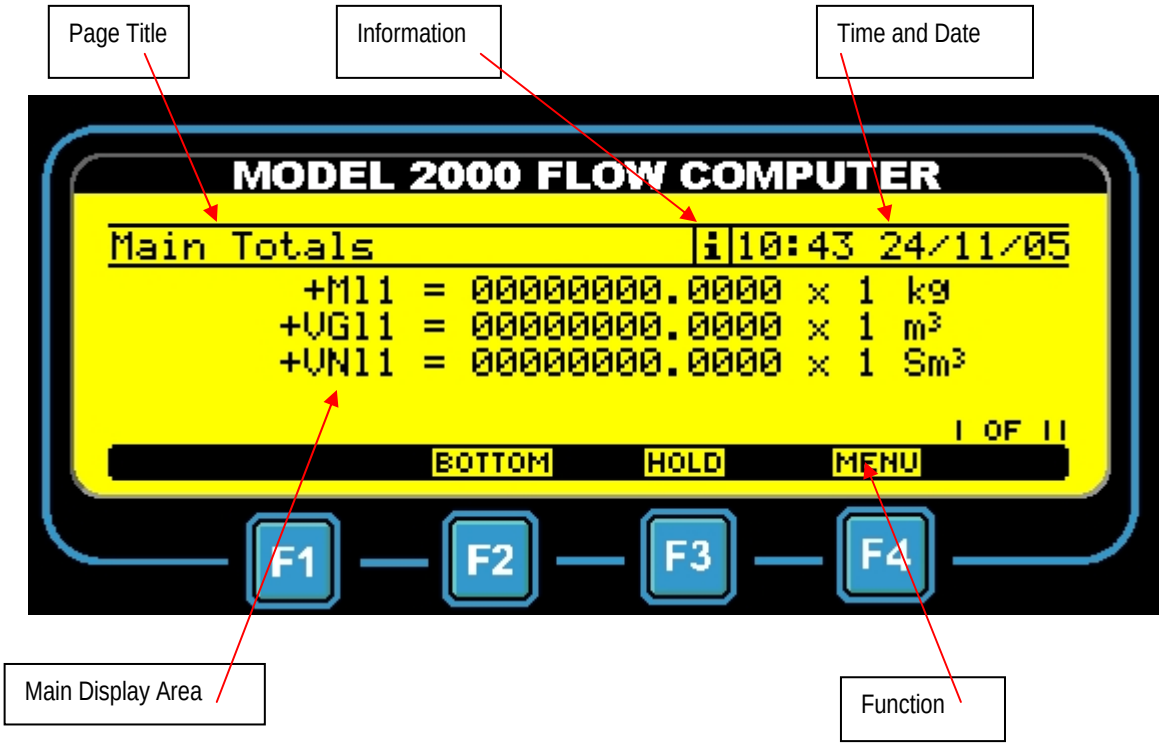
On earlier models of the Model 2000 in the bottom left hand corner as shown in Figure 1 is a small opaque red window, this is the Infra red programming port. It is designed such that a PC equipped with a Remote Infra red device connected externally to one of its communication ports can send and receive data to the Model 2000 through this port, without any physical contact.

On later models of the Model 2000 in the bottom left hand corner as shown in Figure 25 is a small USB A type connector, this is the Front panel programming port. It is designed such that a PC equipped with USB ports can be connected directly to this connector using a USB A to A cable supplied with the Model 2000. Specific drivers which enable this function to work correctly are supplied on the install disc of the Model 2000 together with installation instructions for the various PC windows platforms.

2.0 GENERAL DESCRIPTION

2.2.4 DISPLAY

The Display of the Model 2000 is divided into a number of sections as can be seen as follows:-



Typical Display Page

The top of the Display page shows the page title, the information symbol (if information is available on this page) and the current Model 2000 time and date.

The centre section is the main display area this generally shows the selected data that is appropriate for this page, together with the page number and total number of pages that applies to the current section.

The bottom line of the display is shown in reverse format and gives the current function of the four function keys F1, F2, F3 and F4.

2.0 GENERAL DESCRIPTION

2.3 MAIN MENU FUNCTIONS

The main operating Menu of the Model 2000 can be accessed in a number of ways depending upon the current operational state of the Model 2000 and the current display page. These methods are either to select Menu using the function keys, or to select Main Menu from the current menu list or if the unit has just been switched on and is displaying the start up page, the Main menu will be on the display.

The items available in the Main menu item list are as follows:-

	Totals
	Line Conditions
*	Coriolis Meter
*	Grab Sampler
*	Chromatograph
*	Station Controller
*	PID Controller
*	Liquid Data
*	Gas Data
	Settings
	Preset Data
	Edit
*	Output set-up
	Alarms
	Events
	Display
	System
	Calibration
	Board Info
*	Information
	General Info

Items marked * will only be shown in the Main Menu if they are selected to operate.

Depending upon the type of machine set-up or connected to, when some of the above items are selected the user will be prompted with a sub-menu to select from the following:-

Station
General
Chromatograph
Stream 1
Stream 2
Stream 3

This menu would be limited to Station, General, Chromatograph, Stream 1 and 2 if the unit was only a two stream device, and to General, Chromatograph and Stream 1 if the unit was a single stream device.

2.0 GENERAL DESCRIPTION

2.3.1 MAIN MENU FUNCTION Totals

This menu item is a read only display and when selected will show all the pages of flow totals available in this machine these will include:-

For Turbine Machines

+Vbu	Uncorrected Volume from Meter “Un-haltable” i.e. always counts
+Vb	Uncorrected Volume from Meter
+Vbc	Uncorrected Volume corrected for meter non-linearity
+Vbcu	Uncorrected Volume corrected for meter non-linearity “Un-haltable” i.e. always counts
+Vb	Uncorrected Volume from Monitor
+Vn	Corrected Volume
+Vnu	Corrected Volume from Meter “Un-haltable” i.e. always counts
+M	Mass
+Mu	Mass “Un-haltable” i.e. always counts
+E	Energy
+Eu	Energy “Un-haltable” i.e. always counts

For Ultrasonic Machines

+Vbu	Uncorrected Volume from Meter “Un-haltable” i.e. always counts
+Vb	Uncorrected Volume from Meter
+Vbcu	Uncorrected Volume corrected for meter non-linearity “Un-haltable” i.e. always counts
+Vb	Uncorrected Volume from Monitor
+Vn	Corrected Volume
+Vnu	Corrected Volume from Meter “Un-haltable” i.e. always counts
+M	Mass
+Mu	Mass “Un-haltable” i.e. always counts
+E	Energy
+Eu	Energy “Un-haltable” i.e. always counts

For Wet Gas Venturi machines

+Mguc	Mass gas from Venturi no correction for wet gas
+Mgc	Mass gas from Venturi corrected for wet gas
+Mlc	Mass liquid corrected
+Ngl	Line Volume of gas
+Ngb	Base Volume of gas
+Nll	Line Volume of Liquid
+Nlb	Line Volume of Liquid
+Mw	Mass of Water
+Mc	Mass of Condensate

All the above Venturi Totals are also available in un-haltable versions

For Wet Gas Venturi type 2 machines

+Mguc	Mass gas from Venturi no correction for wet gas
+MgS	Mass saturated gas from Venturi corrected for wet gas
+MgD	Mass dry gas from Venturi corrected for wet gas
+ML	Mass liquid corrected
+MTP	Mass two phase product including Water
+MC	Mass condensate liquid corrected
+MW	Mass Water liquid corrected

2.0 GENERAL DESCRIPTION

+MM Mass Methanol liquid corrected
+Mhc Mass Hydro Carbon corrected
+VnG Standard Volume of gas
+VnC Standard Volume of condensate
+VnW Standard Volume of Water
+E Energy

All the above Venturi Totals are also available in un-haltable versions

For Coriolis meter machines

+Ml Mass of Liquid in kg primary flow source.
+Mls Mass of Liquid in kg secondary flow source.
+VGl Volume of Liquid at Line conditions in m3
+VNl Volume of Liquid at base conditions in m3
+Mw Mass of Water in kg.
+VGw Volume of Water at Line conditions in m3
+VNw Volume of Water at base conditions in m3
+Mc Mass of Condensate in kg.
+VGc Volume of Condensate at Line conditions in m3
+VNc Volume of Condensate at base conditions in m3

All the above Coriolis Totals are also available in un-haltable versions

Primary and secondary source from the Coriolis meter can be either serial data via Modbus communication or pulse accumulation via pulse input.

For All machine types if enabled

+CO2 Mass of CO2

Which are then sub-divided into groups as follows:-

Main Totals

Alarm Totals

Main Totals when HOLD function last operated

Alarm Totals when HOLD function last operated

Current 15 min, Hour, Day and Month non-accumulated Totals

Previous 15 min, Hour, Day and Month non-accumulated Totals

Last Day non-accumulated Totals

Previous Hour, Day and Month accumulated Totals

Previous Hour, Day and Month accumulated Alarm Totals

Current Hour, Day and Month non-accumulated Alarm Totals

Previous Hour, Day and Month non-accumulated Alarm Totals

Last Day and non-accumulated Alarm Totals

The items will be divided into pages with a maximum of four items per page, each item will be displayed with the corresponding symbols, scaling factors and units.

2.3.2 MAIN MENU FUNCTION Line Conditions

This menu item is a read only display and when selected will show all the pages of line conditions available in this machine these will include:-

General sub-menu items, i.e. items that relate to the machine and not specifically to streams.

Digital Input Status

The Status inputs appear as Digital i/p X.Y on the M2000 display

2.0 GENERAL DESCRIPTION

Where

X is the input number 1, 2 or 3
Y is the USER Board Slot number 1, 2, 3, 4 or 5.

Stream N	sub-menu items, i.e. items that relate to the streams

Flow Rates

Peak Flow rates and Time and Date of occurrence

Line Pressure and Temperature and status

Line and Base Compressibility

Line Density

Correction Factors

Meter Information

Station	sub-menu items, i.e. items that relate to station functions only in a Multistream machine.

Station Flow rates

The items will be divided into pages with a maximum of four items per page, each item will be displayed with the corresponding symbols, scaling factors and units.

2.3.3 MAIN MENU FUNCTION Coriolis Meter

This menu item is a read only display and when selected will show the status of any serially connected Liquid Coriolis Meter and Meter data, this page will only be shown if a Coriolis M2000 type has been selected using the M2000 windows software. The data items available are as follows:-

Current read Status	Reading Data or Waiting
Last read Status	OK or Comms Problem
CM Status	Meter Status Information
CM Mass	Meter Mass flow rate in kg/hr
CM Density	Meter Density in kg/m3
CM Volume	Meter Volume flow rate in m3/day
CM temperature	Meter Temperature
CM pressure	Meter Pressure

CM Mass and Volume Totals

The items will be divided into pages with a maximum of four items per page.

2.3.4 MAIN MENU FUNCTION Grab Sampler

This menu item is a read only display and when selected will show a sub menu as below:-

Sampler 1
Sampler 2

Sampler 1 shows the status and operational state of Liquid Grab Sampler 1 and Sampler 2 shows the same information for Liquid Grab Sampler 2.

The data items available are as follows:-

Sampler current and remaining Volume in cc

Sampler Volume in m3

Required, current and remaining Sampler pulses to fill the can

Sampler Rate in cc/m3

2.0 GENERAL DESCRIPTION

Can fill level in %

Grab Sampler Status

The items will be divided into pages with a maximum of four items per page.

2.3.5 MAIN MENU FUNCTION Chromatograph

This menu item is a read only display and when selected will show the status of any connected Gas Chromatograph, this page will only be available if a gas chromatograph has been set up using the M2000 windows software. The data items available are as follows:-

Current read Status	Reading Data or Waiting
Last read Status	OK or Comms Problem
Chr Stream Number	
Chr Analysis	N/A, Analysis or Calibrate
Chr State	N/A, Idle, Analysis or Calibrate
Chr Status 1	16 bits of Status
Chr Status 2	16 bits of Status

The items will be divided into pages with a maximum of four items per page. See Appendix 3 for details of Gas Chromatographs that are supported and the Modbus Communication addresses that are read by the Model 2000. Not all the above data items may be available for all types of Gas Chromatograph.

2.3.6 MAIN MENU FUNCTION Station Controller

This menu item is a read only display and when selected will show all the pages of data relating to the set up of the Station Controller.

This will include

Number of Connected units and their communication ids.

Current operating Status of Read and Writes to those units.

2.3.7 MAIN MENU FUNCTION PID Controller

This menu item is a read only display and when selected will show all the pages of available information that relate to the Proportional, Integral and Derivative control outputs in this machine.

2.3.8 MAIN MENU FUNCTION Gas Data

This menu item is a read only display and when selected will show a sub menu as below:-

Preset
Received
Used
Hourly Average
Daily Average

The menu item Preset contains all gas data max, min, hi, lo and keypad entry values.

The menu item Received contains all gas data values that have been received either from a connected gas chromatograph or from a supervisory system or as analogue inputs, together with the status of that number for example N/A which means not available, a value has not been received.

The menu item Used contains the gas data values that are being used in the Model 2000 and the origin of the number i.e. Keypad, OK or LGV.

The menu items Hourly and Daily averages display the current average values for all the gas components. The Hourly average is calculated over the last complete hour and the daily average is calculated over the last complete day from contract hour to contract hour. The Hourly and Daily Averages can be selected to be calculated from either received Chromatograph values, received Serial (Modbus) values or received analogue values.

2.0 GENERAL DESCRIPTION

All of the items of Gas data in this machine will be divided into pages with a maximum of four items per page, each item will be displayed with the corresponding symbols, scaling factors and units.

Relative Density

Superior and Inferior Heating Values

All Gas components in Molar percent form

Plus Wobbe and C6+ as received from the Gas Chromatograph

2.3.9 MAIN MENU FUNCTION Liquid Data

This menu item is a read only display and when selected will show a sub menu as below:-

Preset
Received
Used
Hourly Average
Daily Average

The menu item Preset contains Specific Gravity (relative density) Liquid data, max, min, hi, lo and keypad entry values together with the units of temperature measurement for liquid correction.

The menu item Received contains Specific Gravity (relative density) Liquid data values that have been received either from a connected chromatograph or from a supervisory system or as analogue inputs, together with the status of that number for example N/A which means not available, a value has not been received.

The menu item Used contains the Specific Gravity (relative density) Liquid data values that are being used in the Model 2000 and the origin of the number i.e. Keypad, OK or LGV.

The menu items Hourly and Daily averages display the current average values for Specific Gravity (relative density). The Hourly average is calculated over the last complete hour and the daily average is calculated over the last complete day from contract hour to contract hour. The Hourly and Daily Averages can be selected to be calculated from either received Chromatograph values, received Serial (Modbus) values or received analogue values.

2.3.10 MAIN MENU FUNCTION Settings

This menu item is a read only display and when selected will show all the pages of Setting Information available in this machine these will include:-

General	sub-menu items, i.e. items that relate to the machine and not specifically to streams.	
Serial Number		up to 8 digits
Contract Hour		0 = Midnight
Energy Units		MJ, Kwh, kcal, therms or BTU
Maintenance Mode		On or Off
Chromatograph	sub-menu items, i.e. items that relate to the gas chromatograph and not specifically to streams or general.	
Chromatograph type		Selected from a list
Communication ID		Modbus id
Read Time		How often data is read
Chromat status		Ignore GC alarms
C6+ code		
% of higher components		
Stream N	sub-menu items, i.e. items that relate to the streams	

Compressibility Equation in use

2.0 GENERAL DESCRIPTION

Combustion /Base Temperatures

Meter Correction Equations in use

Orifice Equations and calculation methods in use

Energy calculation using Superior or Inferior Heating Values

Total or Flow rate suspension under Low Flow conditions

Total or Flow rate suspension under Alarm conditions

Alarm Counter functions

Gas data alarm use Last Good Value or Keypad

Gas Chromatograph stream number

Station — sub-menu items, i.e. items that relate to station functions only in a Multistream machine.

Sum Stream into Station Totals or Flow rates

The items will be divided into pages with a maximum of four items per page, each item will be displayed with the corresponding symbols, scaling factors and units.

2.3.11 MAIN MENU FUNCTION Preset Data

This menu item is a read only display and when selected will show all the pages of Pre-set Data available in this machine these will include:-

Alarm Levels (not gas data)

All Constants

Base Conditions

Number of Pressure Sensors and On/Off for each

Pressure Sensor selection

Pressure sensor deviation and keypad values

Pressure Units and Gauge or Absolute

Number of Temperature Sensors and On/Off for each

Temperature Sensor selection

Temperature sensor deviation and keypad values

The items will be divided into pages with a maximum of four items per page, each item will be displayed with the corresponding symbols, scaling factors and units. Any item that has no value or has not been set will be shown as --------

2.3.12 MAIN MENU FUNCTION Edit

This menu item when selected will show all the pages of data available in this machine that have been set-up so that the items can be altered or edited via the Keyboard and Display of the Model 2000.

When this menu item is selected the user will be prompted to enter a four digit numeric password, to gain access to the data items. It is possible to set-up a maximum of three different passwords and each of these passwords can be set to allow access to a different set of data items.

In its factory default condition the three available passwords are 1111, 2222 and 3333. These allow access to the following areas:-

Operator 1

Password 1111

- Pre-set all Main counters
- Reset all Main Counters to Zero
- Reset all peak flows to zero
- Alter all Settings items
- Alter all available pre-set numbers
- Adjust the Time and Date

2.0 GENERAL DESCRIPTION

Operator 2
Password 2222 — Alter all Settings items
Alter all available pre-set numbers
Adjust the Time and Date

Operator 3
Password 3333 — Alter all available pre-set numbers
Adjust the Time and Date

If an incorrect password is entered or the Model 2000 is in secure mode then access to the Data items will be denied.

If the Model 2000 is set into the partially secure Mode (See Section 2.1.2) then Operator3 / Password 3333 will remain fully secure on the Model 2000 and no access will be granted to any data under this position.

Once access to the Edit mode has been achieved, a selection menu will appear and the required group of data must be selected.

Exit		Exit mode (see following section)
General		All general data items
Chromatograph		Set-up Data for Chromatographs
Station		Set-up Data for Station items
Stream N	General	General Stream data
	Gas Data	Stream related Gas Data
or	Liquid Data	Stream related Liquid Data
Time and Date		Time and Date Set-up
Station Controller		Station Controller Set-up

The items to be altered are selected by moving the display cursor to the required data item using the [↑] (for up) and [↓] (for down) cursor keys and selecting by pressing the enter or return key. The new value is then entered using the numeric key pad and finally pressing the enter or return key to confirm. At this stage in the edit session the number changes have been recorded but are not being used by the Model 2000, the user can go on to alter as many data items as are required. Once all the changes are complete the user can Exit the EDIT section by selecting the function key EXIT. Selecting the EXIT function will prompt with a EXIT menu as follows:-

Exit & Save	Exit the edit mode, save the changes to memory and use the new values.
Exit & No Save	Exit the edit mode, do not action any of the changes made.
Undo	Do not exit edit mode and undo all previous changes in this session.

2.3.13 MAIN MENU FUNCTION Output set-up

This menu item when selected will allow Analogue Output functions and Digital Pulse Output functions that have previously been set-up in the unit to be altered or edited via the Keyboard and Display of the Model 2000.

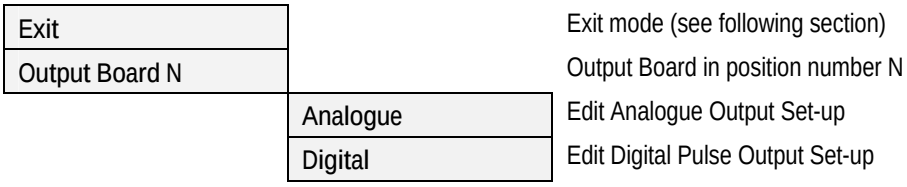
When this menu item is selected the user will be prompted to enter a four digit numeric password, to gain access to the calibration pages. It is possible to set-up a maximum of three different passwords and each of these passwords can be set to allow access or not to the calibration pages, these passwords are the same as used in the EDIT mode.

2.0 GENERAL DESCRIPTION

In its factory default condition the three available passwords are 1111, 2222 and 3333.

If an incorrect password is entered or the Model 2000 is in secure mode then access to the Data items will be denied.

Once access to the Output set-up mode has been achieved, a selection menu will appear and the required group of data must be selected.



The functions to be edited are selected by moving the display cursor to the required item using the **[↑]** (for up) and **[↓]** (for down) cursor keys and selecting by pressing the enter or return key.

If Analogue is selected then a page is shown for each of the four Analogue outputs on a particular Output board. Each page has variables:-

Value	Analogue Output Variable name, can be altered from items in list.
Abs	Absolute function On or Off.
Max	Output maximum scaling factor.
Min	Output minimum scaling factor.
Stream	Flowing stream number.
Cal	Calibration function min or max.

The items to be altered are selected by moving the display cursor to the required data item using the **[↑]** (for up) and **[↓]** (for down) cursor keys and selecting by pressing the enter or return key. The new value is then entered using the numeric key pad or selected from a list and finally pressing the enter or return key to confirm.

It is only possible to edit previously configured (by the M2000 Windows operating software) Analogue Outputs. All outputs that have not been configured. will appear with each of the above variables shown as ---------, these items cannot be changed using the Front panel functions.

If Digital is selected then a page is shown for each of the twelve Digital outputs on a particular Output board. Each page has variables:-

Value	Digital Pulse Output Variable name, can be altered from items in list.
Invert	Output Inversion On or Off.
Cycle	Output duty cycle, can be altered from items in list.
Divide	Output pulse scaling factor.
Stream	Flowing stream number.
Freq.	Pulse Output frequency.

The items to be altered are selected by moving the display cursor to the required data item using the **[↑]** (for up) and **[↓]** (for down) cursor keys and selecting by pressing the enter or return key. The new value is then entered using the numeric key pad or selected from a list and finally pressing the enter or return key to confirm.

It is only possible to edit previously configured (by the M2000 Windows operating software) Digital Pulse Outputs. All outputs that have either not been configured or that are set to another function e.g. Alarm output, will appear with each of the above variables shown as ---------, these items cannot be changed using the Front panel functions.

2.0 GENERAL DESCRIPTION

Once all the changes are complete the user can Exit the Output Set-up section by selecting the function key EXIT. Selecting the EXIT function will prompt with a EXIT menu as follows:-

Exit & Save	Exit the Output set-up mode, save the changes to memory and use the new values.
Exit & No Save	Exit the output set-up mode, do not action any of the changes made.

2.3.14 MAIN MENU FUNCTION Alarms

This menu item when selected will prompt the user with an alarm type selection menu as follows:-

Main Menu	Return to Main Menu
All	Display all alarm types
Faults	Display all Faults
Acc. Alarms	Display all accountable alarms
Non. Acc. Alarms	Display all non-accountable alarms
Warnings	Display all warnings

Each of the above Alarm type selections will allow access to the selected alarm list. The alarms are listed in order of Time and Date as they occurred most recent at the top. Each alarm listing will contain the alarm type (See appendix 1 for details) in symbol form the time and date that the alarm was Set (ON) and if the alarm has been cleared (OFF), the clear time and date. The Model 2000 allows the display of up to 168 current and past alarms, the cursor keys allow the various pages to be viewed. All alarms with an ON and OFF time (i.e. alarms that are no longer current) can be cleared from the list, by pressing the function Key marked CLEAR.

2.3.15 MAIN MENU FUNCTION Events

This menu item when selected will display all recorded events within the Model 2000 together with the time and date that they were recorded.

Each Event will be listed in three columns the description of the event (See Appendix 2 for a list of all possible events) , the event entry number and the Time and Date that it occurred. The Model 2000 allows the display of up to 500 Events, the cursor keys allow the various pages to be viewed. All Events can be cleared from the list, by pressing the function Key marked CLEAR.

2.3.16 MAIN MENU FUNCTION Display

This menu item when selected will prompt the user with a selection menu as follows the items in the menu relate to display and Keyboard functions:-

Contrast	Sets the contrast of the Main display Lighter or Darker
Backlight	Allows the Main display back light to be permanently On, permanently Off or selected to be On for a selected period of time in minutes after the last keyboard operation
Key repeat	Allows the Key Repeat function to be set On or Off
Exit	Returns operation to the Main Menu

2.0 GENERAL DESCRIPTION

2.3.17 MAIN MENU FUNCTION System

This menu item when selected will allow the operator to alter a number of system functions. When selected from the Main Menu a sub menu will appear as follows:-

Edit On/Off	Alters the System Edit function from view only to edit.
Comms.	Allows the Front panel communication options of baud rate and Comms id to be viewed or changed.
Exit	Returns operation to the Main Menu

Once any changes made are complete the user can leave the SYSTEM section by selecting the function key RETURN. Selecting the RETURN function will prompt with a EXIT menu as follows:-

Exit & Save	Exit the calibration mode, save the changes to memory and use the new values.
Exit & No Save	Exit the calibration mode, do not action any of the changes made.

2.3.18 MAIN MENU FUNCTION Calibration

This menu item when selected will allow access to the Input parameters that will require calibration via the Keyboard and Display of the Model 2000.

When this menu item is selected the user will be prompted to enter a four digit numeric password, to gain access to the calibration pages. It is possible to set-up a maximum of three different passwords and each of these passwords can be set to allow access or not to the calibration pages, these passwords are the same as used in the EDIT mode.

In its factory default condition the three available passwords are 1111, 2222 and 3333.

Once the password has been entered and accepted a calibration sub menu will appear as follows:-

Outputs	Selects calibration of any Analogue output.
Analogue	Selects calibration of any Analogue input.
Hart	Selects calibration of any Hart Loop input.
Exit	Returns operation to the Main Menu.

Each Analogue input calibration page relates to a single input parameter and will show the item being calibrated and its circuit board position, a High and Low calibration point and the current value for that input.

The display cursor can be moved between the High and Low Calibration values using the **[↑]** (for up) and **[↓]** (for down) cursor keys and selecting by pressing the enter or return key. The new value is then entered using the numeric key pad and finally pressing the enter or return key to confirm.

At this stage in the calibration session the High and Low calibration point number changes have been recorded but are not being used by the Model 2000. The input parameter should now be physically altered until it corresponds to the High or Low calibration point and the display cursor set to point at which ever (High or Low) calibration point is being entered. The SET function key should be operated to set the physical input variable to the High or Low calibration point. The procedure can then be repeated for the other calibration point and can also be repeated as many times as required. It is recommended that the High and Low calibration points are as far apart in the span of the input as is practical and that should at least be at the extremes of the intended operating area. At any time in the calibration session the operator can revert back to either the DEFAULT or PREVIOUS calibration by operating the RESTORE function key and selecting the appropriate item.

2.0 GENERAL DESCRIPTION

Each Hart input calibration page relates to a specific Hart Loop the position of the loop will be shown on the top left hand corner of the calibration page and will refer to SLOT 1 to 5 defining the User board positions (See figure 2 for positions) and Loop 1 or 2 (See appendix 3 for connections). The Hart Calibration page will show all transmitters (up to 3) currently configured for that loop and the process variables and units being read from them. The Calibration page will allow the communication to the Hart transmitters to be switched ON (Normal condition) or to be switched OFF (Calibrate condition) So that a Hart loop calibrator can be connected to the system and each of the connected transmitters calibrated or checked.

NOTE it is not possible to individually turn off the transmitters on one loop , all must be either ON or OFF.

All Analogue outputs can be calibrated on the Output calibration page. The operator is prompted to:

Select the level of the analogue outputs

The F1 key will then select the Minimum range value either 0mA or 4mA, the value will depend upon the actual setting of the output board.

The F2 key will then select the Maximum range value either 20mA or 24mA, the value will depend upon the actual setting of the output board.

NOTE All Analogue Outputs in the M2000 will be set to either the Min or Max values at the same time when the unit is operated in this mode.

The user can go on to calibrate as many Hart or Analogue input parameters or Analogue Output stages as are required. Once all the changes are complete the user can Exit the EDIT section by selecting the function key EXIT. Selecting the EXIT function will prompt with a EXIT menu as follows:-

Exit & Save	Exit the calibration mode, save the changes to memory and use the new values.
Exit & No Save	Exit the calibration mode, do not action any of the changes made.
Undo	Do not exit calibration mode and undo all previous changes in this session.

Any HART loop left in the OFF state when exiting the Calibrate mode will automatically be switched ON when the unit is returned to the running condition.

All Analogue Outputs will be set to the normal operating function after leaving the Calibrate mode.

2.3.19 MAIN MENU FUNCTION Board Info

This menu item when selected will display Information pages giving details of all the user fitted circuit boards:-

Slot 1	Information about Circuit Board fitted in User Slot 1.
Slot 2	Information about Circuit Board fitted in User Slot 2.
Slot 3	Information about Circuit Board fitted in User Slot 3.
Slot 4	Information about Circuit Board fitted in User Slot 4.
Slot 5	Information about Circuit Board fitted in User Slot 5.

Select the User Slot position from the above list, Information will be displayed about the Circuit Board fitted in that slot , this will include:-

2.0 GENERAL DESCRIPTION

Circuit Board type	For Example Input 2 Board
Circuit Board Version	
Software Version	
IP Address	Network 2 Board Only

2.3.20 MAIN MENU FUNCTION Information

This menu item when selected will allow access to the Information pages (1 to 6) that have been set up using the Model 2000 Windows software. If no pages have been set up then this menu item will not appear. It is intended that the information pages are used for data such as Approval Information, Calibration Information and Transmitter Information. Up to six pages can be set up and these can contain both text and bit map information.

2.3.21 MAIN MENU FUNCTION General Info

This menu item when selected will display General Information pages giving the following information :-

Model 2000 type	Gas or Liquid Turbine, Ultrasonic or Orifice Turbine (Density) or Ultrasonic (Density) or Orifice (Density) Venturi Tube type 1 or 2 Station Controller Coriolis Meter
Software version number.	
Instrument serial number.	
Security setting	Fully Secure Partially Secure Not Secure
Unit programme Checksum	
Data Checksum	

2.0 GENERAL DESCRIPTION

2.4 MODEL 2000 FUNCTIONS

2.4.1 PRE-SET VALUE OF TOTAL FLOWS

The initial value of the Main totals for all available Streams and the Station can be set to a pre-set value by entering the EDIT main menu item and entering the starting value for the required total. Upon exit from the EDIT mode the total will start counting flow from the new value.

2.4.2 RESET OF TOTAL FLOWS TO ZERO

The Main totals for all available Streams and the Station can be RESET to zero by entering the EDIT main menu item and YES for the Counter option on the RESET page. Upon exit from the EDIT mode the totals that have been RESET to zero will start counting flow from zero.

The Peak flow rates and the time they occurred for all available Streams and the Station can be RESET by entering the EDIT main menu item and YES for the peaks option on the RESET page.

2.4.3 CLOCK

A clock is built into the Model 2000 which gives the time and date shown on the display and is used for alarm recording, peak flow calculation and many other functions to give accurate timing of events. The clock is set in the EDIT mode by selecting the Time and Date menu item in the EDIT menu, the cursor keys and function keys can then be used to individually adjust the years, months, days, hours, minutes and seconds.

The clock is powered by an internal lithium battery when the Model 2000 power is removed, the battery will power the clock for 1 year with the Model 2000 un-powered.

2.4.4 MAINTENANCE MODE

The Model 2000 can be set to operate in a Maintenance Mode, this can be set up in the EDIT mode. The function of the maintenance mode is to operate the Model 2000 such that flow would be totalled on the Alarm counters and not on the Main counters when in this mode.

When in the maintenance mode in either a Turbine or Ultrasonic machine, the operator can set the M2000 to use a preset value for its flow rate input rather than the measured input. This function is set in the windows operating software.

When in the maintenance mode the following functions will occur:-

A Warning is indicated.
All Alarm digital Outputs are set to the no alarm position.
All Totals pulse outputs are inhibited.
All Flow rate alarms are suppressed.
All Analogue Outputs are set to the minimum value
Grab Sampler system suspends sampling.

2.4.5 PROVING MODE

The Model 2000 can be set to operate in a Proving Mode, this can be set up in the EDIT mode. The function of the proving mode is to operate the Model 2000 such that flow would be totalled on the proving counters and not on the Main counters when in this mode. When in the proving mode a Warning is indicated.

2.4.6 HOLD TOTALS

The Model 2000 can be set to provide copies of the Main and Main Alarm Totals that can be stopped or Held by operating a front panel Button. These Totals in a Held position must be enabled in order to be viewed under the Main Menu item Totals. When displaying the Main Menu item Totals Function Key F3 will have the function HOLD, when this function is operated the current value of the Main Totals and Main Alarm Totals is copied across to the Main Held counters and Main Held Alarm counters. The values will be copied every time the HOLD key is operated. The HOLD key is only operational when the Main Menu item Totals is being displayed. Alternatively the HOLD function can be operated by a switch contact connected to one of the available Status inputs provided the input is set for a Hold Counters function.

2.0 GENERAL DESCRIPTION

2.4.7 CO2 EMISSION CALCULATION

The Model 2000 can be set to calculate an emission factor for CO2 based upon the Energy content of the measured Natural Gas. The function is enabled ON or OFF, if enabled an Emission Factor for CO2 will be calculated together with a Mass Total. See the following equations:-

1) $$EF = \sum M\%M_c \times \frac{P_b}{R \times (273.15 + T_b)} \times \frac{M_{co2}}{10^6}$$

2) $$TotalCO2 = TotalGasVolume(Nm3) \times EF \times 0.995$$

Where

EF	:	CO2 Emission Factor in t CO2/m3	Equation 1)
TotalCO2	:	Total of Co2 in metric tonnes	Equation 2)
R	:	Gas Constant 0.008314510 Mpa m3/kmol.K	DATA ENTRY
t_b	:	Base Temperature in °C	DATA ENTRY
M_{co2}	:	Molar Mass of CO2 44.01	DATA ENTRY
p_b	:	Base Pressure in Bar.a	DATA ENTRY

2.0 GENERAL DESCRIPTION

2.5 INPUT SIGNALS

It is possible to configure the Model 2000 to accept either flow measuring inputs from a pulse generating turbine meter (paragraphs 2.5.1 apply) or as a direct digital reading from an Ultrasonic meter (paragraphs 2.5.2 apply) or using differential pressure measurement across an orifice plate or Venturi (paragraphs 2.5.3 apply) or using a Coriolis meter (paragraphs 2.5.4 apply)

2.5.1 TURBINE METER

If the M2000 is configured to accept turbine pulse inputs then these will be of the form of one or two periodic input signals with the following parameters.

Current input: 10mA.

Frequency range: Up to 5kHz.

One input is defined as the reference frequency input (rf), low frequency input (lf) or monitor input and the other as the high frequency input (hf) or meter input. The high frequency input is used to calculate all of the total flows. The reference frequency input is used for blade failure checking, an uncorrected volume is also obtained from this input.

The calculation of total flow continues down to zero turbine frequency as input pulse counting techniques are used.

If Turbine Meters with low frequency relay contact outputs i.e. less than 20Hz are intended to be used then an input de-bounce circuit should be selected (See Section 4.3 for link settings).

2.5.1.1 MINIMUM INPUT FREQUENCY

The minimum input frequency that is used to calculate flow rate and is used to indicate an alarm condition can be selected to be between 0.004 Hz and 1 Hz by entering a value for f min. The value of f min used determines the time elapsed before a loss of a turbine meter input signal, this time is equal to 1/f min. in seconds.

2.5.1.2 TURBINE METER LINEARISATION

A facility is provided which gives the option of linearise the turbine meter input which is connected to the high frequency input. The options available are:-

off No correction.

20 pnt Linearity correction using 20 point interpolation.

The meter is characterised by entering up to twenty co-ordinates for flow and corresponding error values which are stored in the Model 2000 memory. A linearity correction applied to the corrected flows by interpolating between the co-ordinate points. Correction is applied to the uncorrected flow rates, uncorrected and corrected total flows.

The value entered into the %Qmax n data location is in % of maximum flow (Q max.) of the meter, this figure can range from – Qmax to + Qmax to allow for different linearity in the opposite flow direction and the value entered in the corresponding %Er.rd n location is the % error of reading. If the output from the meter is less than the actual flow through the meter then the error is entered as a negative value.

%Er.rd n = the % error in reading of the meter flow rate at %Qmax n flow rate.

n is an integer between 0 and 19

The lowest value of flow in this case nearest to –Qmax (or nearest to zero flow if the flow is only in the +ve direction) must be entered at the position n = 0. The rest of the data points must be entered in ascending value of Q up to the top point. If it is required to enter less than the maximum 20 points then any unused data positions must be set to invalid data by entering a – sign with no numbers.

2.5.1.3 BI-DIRECTION METER OPERATION

The Model 2000 can be configured to operate from a Flow Meter that can produce a pulse output for flow in both the forward or + direction and the reverse or – direction. If the unit is set to operate in this way the flow Totals are shown as separate positive totals for the forward direction and negative totals for the reverse direction. Flow rates are shown with the appropriate sign. Flow direction is set by a Digital status input, Status input 3 is reserved for this function. The input is set Open or Off for Forward or + flow and Closed or On for Reverse or negative flow. See paragraph 2.5.9 for details.

2.0 GENERAL DESCRIPTION

2.5.1.4 BLADE FAILURE DETECTION

Turbine Meter blade failure check is accomplished by comparing the pulses from sensors on the turbine meter and turbine monitor wheels or from two sensors on the turbine meter wheel. The ratio of pulses from the turbine meter sensor and turbine monitor sensor is entered as the BR and is defined as the blade ratio.

$$\textbf{Blade Ratio} = \frac{\textbf{Number of turbine blades}}{\textbf{Number of monitor segments}}$$

The time periods that the BR check will be done over depends upon the values set for the following parameters:-

BR	Blade Ratio.
Qmax	Maximum Meter flow in m3/hr.
impw	Meter HF impulse factor.

1) If $\mathbf{BR > 3}$ and $\frac{\mathbf{BR \times 3600}}{\mathbf{Q_{max} \times impw}} \geq \mathbf{100}$

Then a BR Check will occur every 1 Monitor input (LF) pulse or every $\mathbf{2 \times BR}$ Meter input (HF) pulses which ever occurs first

An Accountable alarm

turbN hf An hf turbine meter alarm (blade failure) will be generated if

$$\frac{\mathbf{((Monitor \times BR) - Meter)}}{\mathbf{Meter}} \geq \mathbf{+0.04}$$

A Non accountable alarm

turbN lf An lf turbine meter alarm (blade failure) will be generated if

$$\frac{\mathbf{((Monitor \times BR) - Meter)}}{\mathbf{Meter}} \leq \mathbf{-0.04}$$

Where

Monitor	=	Number of Monitor pulses in time period.
Meter	=	Number of Meter pulses in time period.
BR	=	Blade Ratio

2) If $\mathbf{BR > 3}$ and $\frac{\mathbf{BR \times 3600}}{\mathbf{Q_{max} \times impw}} \geq \mathbf{10 < 100}$

Then a BR Check will occur every 10 Monitor input (LF) pulses or every $\mathbf{11 \times BR}$ Meter input (HF) pulses.

An Accountable alarm

turbN hf An hf turbine meter alarm (blade failure) will be generated if

$$\frac{\mathbf{((Monitor \times BR) - Meter)}}{\mathbf{Meter}} \geq \mathbf{+0.04}$$

A Non accountable alarm

turbN lf An lf turbine meter alarm (blade failure) will be generated if

$$\frac{\mathbf{((Monitor \times BR) - Meter)}}{\mathbf{Meter}} \leq \mathbf{-0.04}$$

Where

Monitor	=	Number of Monitor pulses in time period.

2.0 GENERAL DESCRIPTION

Meter = Number of Meter pulses in time period.
BR = Blade Ratio

3) For all other conditions a BR Check will occur every 100 Monitor input (LF) pulses or every $\mathbf{110 \times BR}$ Meter input (HF) pulses.

An Accountable alarm
turbN hf An hf turbine meter alarm (blade failure) will be generated if

$$\frac{\left(\mathbf{Monitor} - \left(\frac{\mathbf{Meter}}{\mathbf{BR}}\right)\right)}{\mathbf{Monitor}} \geq \mathbf{+0.04}$$

A Non accountable alarm
turbN lf An lf turbine meter alarm (blade failure) will be generated if

$$\frac{\left(\mathbf{Monitor} - \left(\frac{\mathbf{Meter}}{\mathbf{BR}}\right)\right)}{\mathbf{Monitor}} \leq \mathbf{-0.04}$$

Where
Monitor = Number of Monitor pulses in time period.
Meter = Number of Meter pulses in time period.
BR = Blade Ratio
The following special conditions will apply for indication of BR alarms:-

a) If the uncorrected flow rate is less than the value of the low flow alarm then the blade failure alarm is inhibited from operating.
b) The blade failure alarm may be switched off by entering zero for the value of blade ratio BR (used where the turbine meter has only one sensor).
c) The result from the next test period carried out after any of the following conditions will not be used to indicate an alarm condition. Any alarm condition will not be indicated until the end of the subsequent test period:-
   i) Immediately following a Power On condition.
   ii) Immediately following the flow increasing above the Low flow level.
   iii) Immediately following a change of BR, Qmax or impw value.

2.5.2 ULTRASONIC GAS METER

The Model 2000 Flow Computer can be connected to a Instromet Ultrasonic Gas Flow Meter type Check, Flare, P or Q Sonic which has 1, 2, 3, 4 or 5 acoustic paths. The electrical connection is made using one of the communication port sockets set up for the purpose.

In a single stream version the communication protocol used is “Uniform” , where a packet of measured data is sent by the meter every second to the M2000.The default communication details are as follows, these can be altered if required:-

RS232
4800 baud
8 data bits
1 stop bit
No parity

In the case of multiple stream Instromet Ultrasonic meter inputs or Use with either the ABB (Sick) Totalsonic, the Panametrics GM868 or Daniel Senior sonic ultrasonic meters the Model 2000 uses a single Modbus RTU communication port configured for multidrop use. When used with any of theses devices the relevant operating instruction manual for those devices should be consulted.

See paragraph 2.9 for details.

2.5.2.1 UNIFORM SOFTWARE

2.0 GENERAL DESCRIPTION

The Model 2000 Flow Computer can be provided with an additional communications port, which can be used to connect to a PC computer (via RS232 connection) which is running the Ultrasonic Diagnostic Software 'UNIFORM'.

This communication port provides the user with direct access to the ultrasonic meter through the Model 2000 without having to make or break any field connections to the actual meter.

The electrical connection is made using one of the communication port sockets set up for the purpose.

The communication details used must be set up to be the same as the communication port for the Ultrasonic meter as listed in paragraph 2.5.2.

All operating details of the UNIFORM software can be found in the relevant Instruction Manual for the Meter and software.

2.5.2.2 METER CORRECTION FOR TEMPERATURE AND PRESSURE

A facility is provided which gives the option to correct the meter flow rate for effects of expansion due to Pressure and Temperature. The options are selected using the parameter P/T Corr eqn. on the Ultrasonic set-up page and are:-

off	No correction
Flange	Correction for Flange Spool piece meters (See Equation).
Weld	Correction for Welded Spool piece meters (See Equation).

For Flanged Spool piece meters

$$Q_c = Q \times \left\{ 1 + \left(3 \times \alpha \times 10^{-6} \times (t_a - t_r) + \left(\frac{3 \times D}{4 \times d \times E} \right) \times (p_a - p_r) \right) \right\}$$

For Welded Spool piece meters

$$Q_c = Q \times \left\{ 1 + \left(3 \times \alpha \times 10^{-6} \times (t_a - t_r) + \left(\frac{7 \times D}{4 \times d \times E} \right) \times (p_a - p_r) \right) \right\}$$

Where

Qc	=	Flow corrected for Pressure and Temperature
Q	=	Flow from Ultrasonic Meter
ta	=	Actual measured temperature in deg C
tr	=	Reference temperature in deg C
D	=	Spool piece inner Diameter in mm
d	=	Wall thickness in mm
E	=	Modulus of Elasticity in BAR
pa	=	Actual measured pressure in BARA
pr	=	Reference pressure in BARA
α	=	Thermal expansion coeff. in 10^6 C^{-1}

2.5.2.3 METER LINEARISATION

A facility is provided which gives the option to linearise the meter line flow rate value. The options are selected using the parameter Lin Corr . on the Ultrasonic set-up page and are:-

off	No correction
20 pnt	Linearity correction using 20 point interpolation.

The meter is characterised by entering up to twenty co-ordinates for flow and corresponding error values which are stored in the Model 2000 memory. A linearity correction applied to the corrected flows by interpolating between the co-ordinate points. Correction is applied to the uncorrected flow rates, uncorrected and corrected total flows.

The value entered into the %Qmax n data location is in % of maximum flow (Q max.) of the meter, this figure can range from – Qmax to + Qmax to allow for different linearity in the opposite flow direction and the value entered in the corresponding %Er.rd n location is the % error of reading. If the output from the meter is less than the actual flow through the meter then the error is entered as a negative value.

%Er.rd n = the % error in reading of the meter flow rate at %Qmax n flow rate.

n is an integer between 0 and 19

The lowest value of flow in this case nearest to –Qmax (or nearest to zero flow if the flow is only in the +ve direction) must be entered at the position n = 0. The rest of the data points must be entered in ascending

2.0 GENERAL DESCRIPTION

value of Q up to the top point. If it is required to enter less than the maximum 20 points then any unused data positions must be set to invalid data by entering a – sign with no numbers.

2.5.2.4 METER ALARMS

A number of separate alarm conditions in the Ultrasonic Meter can be recognised and indicated as follows:-

ACCOUNTABLE METER ALARMS

An accountable alarm will be indicated if any of the following conditions occur:-

If no valid communication is received from the meter for 5 consecutive seconds after this time the flow rate will be set to zero.

If the number of acoustic paths set in the Model 2000 is different from number indicated by the meter.

If an invalid floating point number has been received from the meter.

If the Security bit in the Meter Status word is set.

If the meter is operating in reduced accuracy conditions as follows:-

Level 1 type		All Swirl paths are functioning within limits
	and	All Axial paths are in an efficiency alarm
		Continue to display and use values from Meter.
Level 2 type		If one or more Axial paths is functioning within limits
	and	One or more Swirl paths are in an efficiency Alarm
		Continue to display and use values from Meter.

NOTES	Level 1 and Level 2 only apply to 3, 4 and 5 path meters	
	For a 3 path meter	Paths 1 and 3 are Swirl
		Path 2 is an Axial
	For a 4 path meter	Paths 2 and 3 are Swirl
		Paths 1 and 4 are Axial
	For a 5 path meter	Paths 2 and 4 are Swirl
		Paths 1, 3 and 5 are Axial

NON-ACCOUNTABLE METER ALARMS

An non-accountable alarm will be indicated if any of the following conditions occur:-

If % efficiency for any acoustic path X is below pre-set limit.

2.5.3 ORIFICE PLATE & VENTURI TUBE MEASUREMENT

The Model 2000 Flow Computer can calculate the Mass flow rate and totals using the method of measuring the differential pressure across an orifice plate or a Venturi Tube.

A number of different calculation methods can be selected and used, these can be set in the main menu item EDIT or can be set-up using the Model 2000 configuration software. The various options are as follows;-

In accordance with International standard ISO 5167-1 : 1997/2003 using the Reader Harris/Gallagher equation for flange, corner or D & D/2 pipe tapings.

In accordance with International standard ISO 5167-1 : 1980 using the Stoltz equation for flange, corner or D & D/2 pipe tappings.

In accordance with International standard AGA3 1994 equations for flange pipe tappings.

In accordance with International standard AGA3 1965 equations for flange pipe tappings.

With a Preset Coefficient of discharge for Venturi applications.

In all cases the Model 2000 will calculate and display Coefficient of discharge, Beta ratio, Reynolds number, Expansion factor for upstream or downstream tappings and other values used within the calculation of mass flow in accordance with the equations and calculation methods as specified in the above standards.

A facility is provided which gives the option to calculate or pre-set the dynamic viscosity used within the calculation of Reynolds number. The options are selected using the parameter Dynamic Viscosity eqn. on the Orifice set-up page and are:-

off	No correction
Calc	Calculated Dynamic Viscosity (See Equation).

$$\mu_{p,t} = \mu_0 \sqrt{\frac{(t + 273.15}{(t_0 + 273.15)}} \times \frac{1 + \dfrac{164}{t_0 + 273.15}}{1 + \dfrac{164}{t + 273.15}} \times (0.99625 + 0.00375 \times p)$$

Where

2.0 GENERAL DESCRIPTION

μ_0 = Reference dynamic viscosity at ref. temperature t0.
$\mu_{p,t}$ = Dynamic viscosity at flowing conditions.
t = Actual measured temperature in deg C.
t0 = Reference temperature for μ_0 in deg C.
p = Actual measured pressure in BARA.

For applications where the measurement of Steam flow is required the Venturi Tube type of Model 2000 must be selected in this case the equations used are for Classical Venturi as defined in International standard ISO 5167-1 : 1997. All measurement inputs are as required for Orifice plate measurement. The only difference is that Look up tables for Steam density are used instead of direct measurement.

2.5.3.1 DIFFERENTIAL PRESSURE MEASUREMENT

2.5.3.1.1 DIFFERENTIAL PRESSURE UNITS

The Units of differential pressure used in the Model 2000 can be set to be any of the following bar, mbar, psi inches of water gauge or mm of water gauge.

In the case of analogue transmitters it is assumed that the 4-20mA current value is calibrated in the required units. However, where HART transmitters are used with digital communication, the units value is read from the transmitter and compared against the value selected, if the value read does not agree with the value selected then the differential pressure received will be converted and displayed in the selected units.

2.5.3.1.2 HART TRANSMITTER DIFFERENTIAL PRESSURE INPUTS

The Model 2000 is designed to be used with either one single (high range) or two (high and low range) differential pressure transmitters using the HART communications protocol. Typical transmitters are the Rosemount Model 3051C Differential Pressure. All communication with the transmitters is done digitally and the analogue signals from the transmitters is set to the minimum value and therefore cannot be used for monitoring purposes. Where two transmitter operation is selected the differential pressure from both the high range and the low range will be displayed, the in use differential pressure is determined by the following selection method.

If the low range d.p. value is below 98% of d.p. low max then the d.p. low range value is used.

If the low range d.p. value is above 98% of the d.p. low max. then the d.p. high range value is used. Once the d.p. high range has been selected the d.p value must fall below 95% of the d.p. low max before the unit switches to using the d.p. low range value.

WARNING:- The transmitters are connected in parallel as a multidrop system and each transmitter must have a different address.

It is essential that the transmitters have their addresses programmed and the burst mode operation turned off before they are connected to the Model 2000 Flow Computer.

For Rosemount Transmitters the Rosemount Smart Family Interface Model 268 is used to programme the transmitter,.

Refer to the Rosemount operating manuals for the programming procedures.

To interface with the hazardous area where intrinsically safe transmitters are used a digital safety barrier must be used a typical barrier is a Measurement Technology Ltd barrier Model MTL3046B or MTL 5042.

2.5.3.1.3 ANALOGUE TRANSMITTER DIFFERENTIAL PRESSURE INPUTS

As an alternative to the HART transmitter inputs described in paragraph 2.5.3.1.2 the Model 2000 can also accept current input signals for differential pressure (Low range and High range) which are fed into an single sided amplifier and having a response time of approximately 470ms.

Input current:	4mA. to 20mA.
Input resistance:	100Ω

The Model 2000 can be used with either one single (high range) analogue (4-20mA) differential pressure transmitter or two (one high range and one low range) analogue (4-20mA) differential pressure transmitters.

Where two transmitter operation is selected the differential pressure from both the high range and the low range will be displayed, the in use differential pressure is determined by the following selection method.

If the low range d.p. value is below 98% of d.p. low max then the d.p. low range value is used.

If the low range d.p. value is above 98% of the d.p. low max. then the d.p. high range value is used. Once the d.p. high range has been selected the d.p value must fall below 95% of the d.p. low max before the unit switches to using the d.p. low range value.

To interface with the hazardous area where intrinsically safe transmitters are used a safety barrier must be used.

2.5.3.2 MASS FLOW MEASURMENT LINEARISATION

2.0 GENERAL DESCRIPTION

A facility is provided which gives the option of linearise the calculated mass flow rate. The options available are:-

off	No correction.
5 pnt	Linearity correction using 5 point interpolation.

The mass flow calculated is characterised by entering five co-ordinates for flow and corresponding error values which are stored in the Model 2000 memory. A linearity correction is applied to the mass flow by interpolating between the co-ordinate points. Correction is applied to the mass flow rate and mass total flows, subsequently as the volume and energy measurements are derived from the mass measurement these will also be corrected.

The value entered into the %Qmax n data location is in % of maximum flow (Q max.) and the value entered in the corresponding %Er.rd n location is the % error of reading.

%Er.rd n = the % error in reading at %Qmax n flow rate.

n is an integer between 0 and 5

The lowest value of flow in this case nearest to zero flow must be entered at the position n = 0. The rest of the data points must be entered in ascending value of Q up to the top point. If it is required to enter less than the maximum 5 points then any unused data positions must be set to invalid data by entering a – sign with no numbers.

2.5.3.3 WET GAS FLOW MEASUREMENT

2.5.3.3.1 WET GAS FLOW MEASUREMENT 1

When operating as a Wet Gas Flow Computer the Model 2000 will operate using Venturi tube calculations as defined in paragraph 2.5.3 above. In addition Wet gas corrections will be applied to the Venturi mass flow measurement from a selected list of options as follows:-.

Dickinson/Jamieson correlation
Steven correlation
Chisholm correlation
De Leeuw correlation
Homogeneous (Measured Density Method)

2.5.3.3.2 WET GAS FLOW MEASUREMENT 2

As an alternative when operating as a Wet Gas Flow Computer the Model 2000 can operate using Venturi tube calculations as defined in paragraph 2.5.3 above and in addition use the De Leeuw correlation for Wet gas corrections to the Venturi mass flow measurement.

This method is primarily intended for use with a Rosemount type 3095 Mass Flow transmitter, which provides the Model 2000 flow computer with measurement data for Differential Pressure, Static Pressure and Temperature these values are input into the Model 2000 Flow Computer by means of a Hart connection loop to the Model 3095 transmitter, all three values are read in at one time.

WARNING:- The transmitters should only be connected individually on a connection loop system and each transmitter must have a different address.

It is essential that the transmitters have their addresses programmed and the burst mode operation turned off before they are connected to the Model 2000 Flow Computer.

For Rosemount Transmitters the Rosemount Smart Family Interface Model 268 is used to programme the transmitter,.

Refer to the Rosemount operating manuals for the programming procedures.

To interface with the hazardous area where intrinsically safe transmitters are used a digital safety barrier must be used a typical barrier is a Measurement Technology Ltd barrier Model MTL3046B or MTL 5042.

2.5.4 CORIOLIS METER

The meter used is a flow transmitter PP-FT-1352 (Micro motion model RFT 9739 it should be equipped with a modbus serial output and a frequency/pulse output representing the mass flow. The FC2000 coriolis flow computer shall receive the flow information using the serial output from the flow transmitter as a source of measured flow. This serial link shall be connected directly to the flow computer which will acquire all available flow, process and diagnostic data. The frequency/pulse output of the Flow Transmitter representing the mass flow rate shall be connected directly to the flow computer as the primary source of measured flow and for use as an integrity check against the serial data. A deviation alarm shall be raised when the flow rates differ by more than an operator entered limit.

2.5.4.1 CORIOLIS METER PULSE OUTPUT

2.0 GENERAL DESCRIPTION

If the M2000 is configured to accept coriolis meter pulse inputs then these will be of the form of a periodic input signal with the following parameters.

Current input: 10mA.
Frequency range: Up to 5kHz.

The calculation of total flow continues down to zero frequency as input pulse counting techniques are used.

2.5.4.2 CORIOLIS METER SERIAL OUTPUT

If the M2000 is configured to accept a serial communication signal from the coriolis meter pulse then these will be of the form of an RS232 or RS485 connection to one of the standard communication ports of the FC2000 see paragraph 2.10.

2.5.4.3 CORIOLIS METER CALCULATIONS

The flow computer calculates the liquid totals and flow rates (gross volume, standard volume and mass) for total liquid, condensate and water. These calculations are based on the measured mass flow and density from the Coriolis flow transmitter.

Volume flow rate equations

1) $$qG_L = qM_L / \rho_{LM}$$

2) $$qN_L = qM_L / \rho_{LS}$$

Where

qM_L	:	Mass flow rate in kg/hr	Measured
qG_L	:	Volume flow rate at line conditions in m3/hr	Equation 1)
qN_L	:	Volume flow rate at base conditions in m3/hr	Equation 2)
ρ_{LM}	:	Line Density of Liquid at metering conditions in kg/m3	Measured
ρ_{LS}	:	Base Density of Liquid in kg/m3	Equation 9)

Calculation of Coefficient of Thermal Expansion CTL

3) $$\alpha_T = \frac{K_0}{(\rho_{LS})^2} + \frac{K_1}{\rho_{LS}} + K_2$$

Temperature Volume Correction Factor Calculation at metering conditions

4) $$CTL_m = EXP - [\alpha_T \times (t_l - t_b) \times (1 + 0.8 \times \alpha_T \times [t_l - t_b])]$$

Pressure Volume Correction Factor Calculation at metering conditions

5) $$CPL_m = \frac{1}{[1 - \beta_m \times (p_l - p_e)]}$$

Calculation of Compressibility Factor at metering conditions

6) $$\beta_m = 0.00001 \times EXP(C)$$

7) $$C = (1.38315 + 0.00343804 \times t_l) - (3.02909 + 0.0161654 \times t_l) \times In(\frac{\rho_{LS}}{1000})$$

8) $$\beta_m = 10^{-4} \times e^{\left(-1.62080 + 0.00021592 \times t_l + \frac{0.87096 \times 10^6}{\rho_{LS}^2} + \frac{4.2092 \times t_l \times 10^3}{\rho_{LS}^2}\right)}$$

2.0 GENERAL DESCRIPTION

Calculation of Liquid Density at base conditions

9) $$\rho_{LS} = \frac{\rho_{LM}}{CTL_m \times CPL_m}$$

Where

α_T	:	Coefficient of thermal expansion of liquid Alpha in °C^{-1}	Equation 3)
CTL_m	:	Meter Correction Factor to API MPMS 12.2.5.3 1st Edition Oct 1995	Equation 4)
CPL_m	:	Meter Correction Factor to API MPMS 12.2.5.4 1st Edition Oct 1995	Equation 5)
ρ_{LM}	:	Line Density of Liquid at metering conditions in kg/m3	Measured
ρ_{LS}	:	Base Density of Liquid in kg/m3	Equation 9)
t_l	:	Line Liquid Temperature in °C	Measured/Data Entry
p_l	:	Line Liquid pressure in Bar.a	Measured/Data Entry
t_b	:	Base temperature in °C	Data Entry
p_e	:	Equilibrium pressure in Bar.a	Data Entry
K_0	:	Temp. independent API constant ASTM-D-1250	Data Entry
K_1	:	Temp. independent API constant ASTM-D-1250	Data Entry
K_2	:	Temp. independent API constant ASTM-D-1250	Data Entry
β_m	:	Compressibility factor in bar^{-1} API MPMS 11.2.1	Equation 6) or 8)
C	:	Intermediate Calculation	Equation 7)

Condensate and Water Mass and Volume flow rate equations

10) $$\varsigma_C + \varsigma_W = 1$$

11) $$\rho_{LS} = (\varsigma_W \times \rho_{WS}) + (\varsigma_C \times \rho_{CS})$$

12) $$\rho_{CM} = \rho_{CS} \times CTL_M \times CPL_M$$

13) $$qM_C = qM_L \times \varsigma_C$$

14) $$qN_C = qM_C / \rho_{CS}$$

15) $$qG_C = qM_C / \rho_{CM}$$

16) $$qM_W = qM_L \times \varsigma_W$$

17) $$qN_W = qM_W / \rho_{WS}$$

18) $$qG_W = qM_W / \rho_{WM}$$

Where

qM_L	:	Mass flow rate Liquid in kg/hr	Measured
qM_C	:	Mass flow rate Condensate in kg/hr	Equation 13)
qN_C	:	Volume flow rate Condensate at base conditions in m3/hr	Equation 14)
qG_C	:	Volume flow rate Condensate at line conditions in m3/hr	Equation 15)
qM_W	:	Mass flow rate Water in kg/hr	Equation 16)
qN_W	:	Volume flow rate Water at base conditions in m3/hr	Equation 17)
qG_W	:	Volume flow rate Water at line conditions in m3/hr	Equation 18)
ρ_{CM}	:	Line Density of Condensate at metering conditions in kg/m3	Equation 12)
ρ_{WM}	:	Line Density of Water at metering conditions in kg/m3	Data Entry
ρ_{LS}	:	Base Density of Liquid in kg/m3	Equation 9)
ρ_{CS}	:	Base Density of Condensate in kg/m3	Data Entry
ρ_{WS}	:	Base Density of Water in kg/m3	Data Entry
ζ_C	:	Condensate Mass Fraction	Derived from Equations 10 & 11

ζ_w	:	Water Mass Fraction	Derived from Equations 10 & 11
CTL_m	:	Meter Correction Factor to API MPMS 12.2.5.3 1st Edition Oct 1995	Equation 4)
CPL_m	:	Meter Correction Factor to API MPMS 12.2.5.4 1st Edition Oct 1995	Equation 5)

Water Mass and Volume percent flow rate equations

19) $$\%qM_W = \frac{qM_W}{qM_L} \times 100$$

20) $$\%qN_W = \frac{qN_W}{qN_L} \times 100$$

21) $$\%qG_W = \frac{qG_W}{qG_L} \times 100$$

Where

qM_L	:	Mass flow rate Liquid in kg/hr	Measured
qG_L	:	Volume flow rate at line conditions in m3/hr	Equation 1)
qN_L	:	Volume flow rate at base conditions in m3/hr	Equation 2)
qM_W	:	Mass flow rate Water in kg/hr	Equation 16)
qN_W	:	Volume flow rate Water at base conditions in m3/hr	Equation 17)
qG_W	:	Volume flow rate Water at line conditions in m3/hr	Equation 18)
$\%qM_W$	:	Mass flow rate Water in % of Total	Equation 19)
$\%qN_W$	:	Normal Volume flow rate Water in % of Total	Equation 20)
$\%qG_W$	:	Gross Volume flow rate Water in % of Total	Equation 21)

2.5.5 PRESSURE AND TEMPERATURE INPUTS

2.5.5.1 PRESSURE UNITS

The Units of pressure used in the Model 2000 can be set to be either bar, Kpa, Kg/cm2 or psi in either absolute or gauge form.

In the case of analogue transmitters it is assumed that the 4-20mA current value is calibrated in the required units. However, in the case of HART transmitters the units value is read from the transmitter and compared against the value selected, if the value read does not agree with the value selected an accountable Unit alarm is raised.

If pressure in absolute units is selected then all pressure values must be entered and are displayed in absolute units.

If pressure in gauge units is selected then all pressure values must be entered and are displayed in gauge units with the following exceptions:-

Pb	Pressure base
Patmos	Mean atmospheric pressure
Pused	Actual pressure used in all calculations

All of which must be entered and are displayed in absolute units.

2.5.5.2 TEMPERATURE UNITS

The Units of Temperature used in the Model 2000 can be set to be either °C or °F.

In the case of analogue transmitters it is assumed that the 4-20mA current value is calibrated in the required units. However, in the case of HART transmitters the units value is read from the transmitter and compared against the value selected, if the value read does not agree with the value selected an accountable Unit alarm is raised.

2.5.5.3 HART TRANSMITTER PRESSURE AND TEMPERATURE INPUTS

The Model 2000 is designed to be used with using the HART communications protocol. Typical transmitters are the Rosemount Model 3051C Pressure Transmitter and a Rosemount Model 3044/3144 Temperature Transmitter. All communication with the transmitters is done digitally and the analogue signals from the transmitters is set to the minimum value and therefore cannot be used for monitoring purposes.

WARNING:- The transmitters are connected in parallel as a multidrop system and each transmitter must have a different address.

2.0 GENERAL DESCRIPTION

It is essential that the transmitters have their addresses programmed and the burst mode operation turned off before they are connected to the Model 2000 Flow Computer. With Rosemount transmitters the Rosemount Smart Family Interface Model 268 is used for this purpose.

It is recommended that the pressure transmitter be programmed with a short address of 01 and the temperature transmitter with a short address of 02.

Refer to the Rosemount operating manuals for the programming procedures.

To interface with the hazardous area where intrinsically safe transmitters are used a digital safety barrier must be used a typical barrier is a Measurement Technology Ltd barrier Model MTL3046B or MTL 5042.

2.5.5.4 ANALOGUE TRANSMITTER PRESSURE AND TEMPERATURE INPUTS

As an alternative to the HART transmitter inputs described in paragraph 2.5.4.3 the Model 2000 can also accept current input signals for Pressure and Temperature which are fed into an single sided amplifier and having a response time of approximately 470ms.

Input current:	4mA. to 20mA.
Input resistance:	100Ω

To interface with the hazardous area where intrinsically safe transmitters are used a safety barrier must be used.

2.5.5.5 PRT TEMPERATURE INPUT

The Model 2000 may also be configured to accept a platinum resistance thermometer (PRT) with a nominal resistance of 100Ω at 0°C and operating range of -20°C to 100°C. PRT linearization is performed by the Model 2000 automatically. The PRT is energised at 3.5mA. with a constant current source and is connected to the Model 2000 in a 3 wire configuration compensating for line resistance changes due to ambient temperature changes.

As an alternative a PRT input board may be fitted on this board there are two PRT input stages which can be used in the 4 wire configuration.

2.5.5.6 PRESSURE & TEMPERATURE SENSOR SCALING

The Model 2000 can also be configured so that each of the connected Pressure or Temperature Sensors can be scaled using a simple equation as follows:-

$$\mathbf{P_1Scale = Offset.1 + (R.1 \times P_1Tx)}$$

Where

P_1 Scale	Pressure P_1Scale is the value passed to the multiple transmitter selection process (See paragraph 2.5.5).
R.1	Pressure P_1 Range Scaling Factor
Offset.1	Pressure P_1 Offset Scaling Factor
P_1 Tx	Pressure P_1 Actual measured

Identical Equations also apply for all Pressure and Temperature Sensor inputs.

2.5.5.7 AVERAGE PRESSURE & TEMPERATURE

The Model 2000 calculates and makes available four averages for the used pressure and temperature values, these are as follows;-

Flow weighted Hourly Average
Flow weighted Daily Average (Contract time to Contract Time)
Time Hourly Average
Time Daily Average (Contract time to Contract Time)

In each case the available average is for the last complete time period either hour or day. These values are available to be displayed, printed etc. no set up is required they are calculated automatically.

2.5.6 MULTIPLE TRANSMITTER INPUTS

2.0 GENERAL DESCRIPTION

The Model 2000 can be configured to use multiple transmitter inputs for pressure, temperature and high and low differential pressure measurements. Each of these input parameters can be configured to use one, two or three transmitter inputs.

Each transmitter input can be individually switched ON or OFF, if selected OFF indication of the parameter value will continue but no alarms will be raised for that input.

Each transmitter input is individually checked for correct in range operation (within Max. and Min. limits) and in the case of HART transmitters for correct communication, correct transmitter units and for transmitter generated alarms.

All available inputs are then checked for deviation against a pre-set limit.

All values that pass all of the above checks are then passed for use to a selection list.

The selection list serves to select the parameter value to be used in all further Model 2000 calculations, it is a list of all possible items that could be selected and the order in which they would be selected for use if available:-

Sensor 1
Sensor 2
Sensor 3
Average of Valid Sensors
Serial Check Value
Keypad Value
None

All available sensor values, the current calculated average, serially written check value and the Keypad entered value will be displayed together with the status of that value, possible status indications are :-

ON OK	Transmitter is ON and Value can be used
OFF	Transmitter is selected OFF
ALM	Transmitter or Value is in Alarm
DEV	Value is outside deviation limit
N/A	Value is not available

The Model 2000 will continuously check all of the above and display the currently used parameter together with its source. The currently used parameter is compared against the High and Low alarm settings if they are available and a non accountable alarm raised if appropriate.

For Calibration purposes it is possible to force the M2000 to use the Serial Check Value as the in-use value even though the Sensor values may not be in alarm. The Serial Check Value must be entered as the 5th Selection in the list, the Calibrate function is then switched On or Off by writing to the Modbus Input parameter "P/T Calibrate".

2.5.7 GAS DATA INPUT

The Model 2000 can be provided with gas composition data in different ways:-

PRESET GAS DATA

SERIALLY WRITTEN GAS DATA FROM MODBUS PORT

GAS DATA RECEIVED DIRECT FROM A GAS CHROMATOGRAPH

ANALOGUE 4-20mA INPUTS FOR SELECTED GAS DATA ITEMS

RELATIVE DENSITY FROM A TRANSDUCER (Periodic Type)

When the Gas data main menu item is selected a sub-menu will appear as follows:-

2.0 GENERAL DESCRIPTION

Preset
Received
Used
Hourly Average
Daily Average

Associated with each gas component and heating value etc. are five parameters these are Maximum, Minimum, High and Low alarm settings and a Keypad or preset value. These values are displayed under the Preset menu item.

If the Model 2000 has either gas data written into it via a suitable Modbus port or is set to receive gas data from a connected gas chromatograph or has Analogue inputs set for gas component values, then the values received will be displayed under the Received menu item. Each item displayed will have a status associated with it as listed below:-

OK	Received Value is valid and can be used
ALM	Received Value is outside Max/Min limits
N/A	Value is not available

The actual gas data values to be used in all calculations etc. will be displayed under the Used menu item and these data values will also be accompanied by an origin status as listed below:-

OK	Used value received and it is valid.
ISO 6976	Used value is calculated from ISO 6976 Standard..
Keypad	Used value is the keypad entered value
LGV	Last Good Value Used value is the last serially received value before a problem.

NORMAL OPERATION

For normal operation the source of the gas values to be used can be selected from the pull down menu list Gas Values (Normal) as follows:-

Use Chromat
Use Modbus
Use Analogue
Use Hourly Average
Use Daily Average

PRE SET GAS DATA

To operate the Model 2000 in preset gas data mode, it is only required to set a keypad value for all gas data items, it is not necessary to enter any Max, Min, Hi or Lo values. Under the Used menu option the Model 2000 will display the gas data values currently being used and the origin status of those values, in this case as the Model 2000 has no other values it will use the keypad values and display the source for each item as Keypad.

GAS DATA FROM A GAS CHROMATOGRAPH

For the gas component values be received directly from a gas chromatograph a communication port must be configured and assigned for that function. As determined by the gas chromatograph configuration set-up the Model 2000 will then periodically interrogate the gas chromatograph for values. These values will be checked as previously described and if they are valid and in range, they will become the gas used values.

GAS DATA FROM MODBUS SERIAL PORT

2.0 GENERAL DESCRIPTION

If the Model 2000 is to operate using serially written gas data from a configured Modbus serial communication port, then values must be written into the received gas value locations. These values will be checked as previously described and if they are valid and in range, they will become the gas used values.

GAS DATA FROM AN ANALOGUE INPUT

If the Model 2000 is to operate using gas data from a configured Analogue input, then values will be measured from the appropriate analogue inputs. These values will be checked as previously described and if they are valid and in range, they will become the gas used values.

HOURLY or DAILY AVERAGE

It is also possible to select the unit to use either the current Hourly average Values or current Daily average values in Normal operation by selecting either the Use Hourly Average or Use Daily Average menu item when setting the unit up. The source of the average values will be determined by the Gas Average selection menu.

Use Chromat
Use Modbus
Use Analogue

ALARM OPERATION

If either the gas data value is in an accountable alarm condition i.e. outside the Max./Min. limits or a connected gas chromatograph is in an accountable alarm condition (See Appendix 1) then the used value can be selected from a number of sources:-

Use Keypad
Use Last Good Value
Use Chromat
Use Modbus
Use Analogue
Use Hourly Average
Use Daily Average

Use Keypad will select the preset or keypad value.
Use Last Good Value will use the last good (non alarm condition) value.
Use Chromat will select the value from a chromatograph if available.
Use Modbus will select the value from a serial input if available.
Use Analogue will select the value from an analogue input if available.
Use Hourly Average uses current hourly average
Use Daily Average uses current daily average

If no LGV is available for example none has been written or read from a gas chromatograph then the Model 2000 will always default to the Keypad value.

2.5.7.1 GAS CHROMATOGRAPH INPUT

The Model 2000 can be set to operate with a Gas Chromatograph input for Gas Data, See paragraph 2.5.6 for details of Gas data inputs and Appendix 2 for details of Gas Chromatograph types that are supported. The following parameters will need to be set up to support the Gas Chromatograph Input:-

Chromatograph Type	Selected from list
Chromatograph Comms id	Must match ID in the GC
Chromat Status	Status alarm indicated or ignored
Chromat read time interval	Set to selected Intervals 1min to 1 hour or continuous

2.0 GENERAL DESCRIPTION

C6+ code — Gas component code used for C6+

% hexane to % decane in C6+ result.

Certain specific Gas Chromatographs (See Appendix 3) will also require the following parameters to be set:-

Gas Component Max. and Min. Scaling factors.

Full Scale factors.

Gas Component Addresses.

The communication port used for the gas chromatograph input be configured to be the same as the communication port on the gas chromatograph and the port function set for gas chromatograph input. See paragraph 2.9.

2.5.7.2 ANALOGUE TRANSMITTER INPUTS FOR GAS DATA

The Model 2000 can accept current input signals for Superior Heating Value Hs, Inferior Heating Value Hi, Relative density rd, Molar % CO2, Molar % N2 and Molar % H2 which are fed into an single sided amplifier and having a response time of approximately 470ms.

Input current:	4mA. to 20mA.
Input resistance:	100Ω

To interface with the hazardous area where intrinsically safe transmitters are used a safety barrier must be used.

2.5.7.3 HEATING VALUE UNITS

The Model 2000 can be set to operate with a Heating value Units as follows, these Units apply to both Superior and Inferior Heating Values. Unit changes will also apply to the Energy Totals and the Energy flow rates. When an Energy Unit is selected it is assumed by the Model 2000 that any values received for Heating Value will be in the selected Units.:-

MJ/m3

kWh/m3

kcal/m3

thrm/m3 (Therms i.e. 1000*kcal)

BTU

2.5.7.4 AVERAGE GAS DATA

The Model 2000 calculates and makes available hourly and daily averages for the gas component values The source of the average values will be determined by the Gas Average selection menu.

Use Chromat
Use Modbus
Use Analogue

Daily Average is calculated from Contract time to Contract time.
In each case the available average is for the last complete time period either hour or day. These values are available to be displayed, printed etc. no set up is required they are calculated automatically.

2.5.8 DENSITY TRANSDUCER INPUTS

The density meter input to the Model 2000 is for a high frequency periodic type meter. It uses the same type of input as would be configured for a turbine pulse inputs and this is of the form of one periodic input signal with the following parameters.

Current input:	10mA.
Frequency range:	Up to 5kHz.

Two basic types of Transducer are supported the Solartron and the Sarasota, these use different calculation methods as defined in paragraphs 2.5.7.3 and 2.5.7.4.

2.0 GENERAL DESCRIPTION

2.5.8.1 MULTIPLE DENSITY TRANSDUCER INPUTS

The Model 2000 can be configured to use multiple transducer inputs for density measurement. It can be configured to use one or two transducer inputs either from the same type of transducer or from different transducer types.

Each transmitter input is individually checked for correct in range operation (within Max. and Min. limits).
All available inputs are then checked for deviation against a pre-set limit.
All values that pass all of the above checks are then passed for use to a selection list.

The selection list serves to select the parameter value to be used in all further Model 2000 calculations, it is a list of all possible items that could be selected and the order in which they would be selected for use if available:-

Density Sensor 1
Density Sensor 2
Calculated from AGA 8
Keypad Value
None

All available sensor values, the calculated value from AGA 8 and the Keypad entered value will be displayed together with the status of that value, possible status indications are :-

ON OK	Transmitter is ON and Value can be used
OFF	Transmitter is selected OFF
ALM	Transmitter or Value is in Alarm
DEV	Value is outside deviation limit
N/A	Value is not available

The Model 2000 will continuously check all of the above and display the currently used parameter together with its source. The currently used parameter is compared against the High and Low alarm settings if they are available and a non accountable alarm raised if appropriate.

2.5.8.2 AVERAGE DENSITY

The Model 2000 calculates and makes available two averages for the used density values, these are as follows;-

Time Hourly Average
Time Daily Average (Contract time to Contract Time)
In each case the available average is for the last complete time period either hour or day. These values are available to be displayed, printed etc. no set up is required they are calculated automatically.

2.5.8.3 SOLARTRON DENSITY TRANSDUCER INPUTS

The basic equation used for calculation of the Line density is as follows:-

1) $$\rho = K_0 + (K_1 \times 10^{-3} \times T) + (K_2 \times 10^{-3} \times T^2)$$

Where

ρ	:	Line Density of gas in kg/m3	Equation 1)
K_0	:	Constant	DATA ENTRY
K_1	:	Constant	DATA ENTRY
K_2	:	Constant	DATA ENTRY
T	:	Density Transducer period in μ Seconds	MEASURED

The density meter measurement can be corrected for the effects of gas temperature, when this is selected the following equation is used, if none is selected the temperature correction is preset to 1:-

2.0 GENERAL DESCRIPTION

2) $$\rho_t = \rho \times \left[1 + K_{18} \times 10^{-4}\left(t_1 - t_0\right)\right] + K_{19} \times 10^{-4}(t_1 - t_0)$$

Where

ρ_t	:	Line Density of gas corrected for temperature in kg/m3	Equation 2)
K_{18}	:	Constant	DATA ENTRY
K_{19}	:	Constant	DATA ENTRY
t_1	:	Line gas Temperature in °C	MEASURED
t_0	:	Reference gas Temperature in °C	DATA ENTRY

The density meter measurement can be corrected for the effects of the velocity of sound in gas by two alternative methods. Firstly as detailed in Equations 3, 4 and 5 as follows and alternatively as in equations 6 and 7 as follows, if none is selected the Vos correction is preset to 1:-

3) $$\rho_a = \rho_t \left[\frac{1 + \left(\frac{K_{VOS} \times 10^4}{T \times C_c} \right)^2}{1 + \left(\frac{K_{VOS} \times 10^4}{T \times C_g} \right)^2} \right]$$

Where

ρ_a	:	Line Density of gas corrected for VOS and temperature in kg/m3	Equation 3)
K_{vos}	:	Constant	DATA ENTRY
C_c	:	Velocity of Sound in Calibration gas	(See Equation 4)
C_g	:	Velocity of Sound in Flowing gas	(See Equation 5)

It is also possible to either preset or calculate both the velocity of sound in the flowing gas and calibration gas used in this equation, if this is selected then the following equations are used:-

Velocity of Sound in Flowing gas

4) $$C_g = \sqrt{\frac{\gamma_0 \times P \times 10^5}{\rho_t}} + (K_5 \times 10^{-6} \times \rho_t^2) + (K_6 \times 10^{-6} \times \rho_t^3)$$

Where

C_g	:	Velocity of Sound in Flowing gas	Equation 4)
γ_0	:	Low Pressure Ratio of Specific Heats	DATA ENTRY
p_l	:	Line gas Pressure in Bar.a	MEASURED
K_5	:	Constant	DATA ENTRY
K_6	:	Constant	DATA ENTRY

Velocity of Sound in Calibration Gas

5) $$C_c = K_{1Cc} + (K_{2Cc} \times \rho_t) + (K_{3Cc} \times 10^{-3} \times \rho_t^2) + (K_{4Cc} \times 10^{-6} \times \rho_t^3)$$

Where

C_c	:	Velocity of Sound in Calibration gas	Equation 5)
K_{1Cc}	:	Constant	DATA ENTRY
K_{2Cc}	:	Constant	DATA ENTRY
K_{3Cc}	:	Constant	DATA ENTRY
K_{4Cc}	:	Constant	DATA ENTRY

Alternative method of correcting for Velocity of Sound in Gas

2.0 GENERAL DESCRIPTION

6) $$\rho_a = \rho_t \left[1 + \left(\frac{K_3}{\rho_t + K_4} \right) \times \left(A - \left(\frac{G}{t_2 + 273.15} \right) \right) \right]$$

7) $$G = \frac{d_b}{\gamma_0}$$

Where

ρ_a	:	Line Density of gas corrected for VOS and temperature in kg/m3	Equation 6)
G	:	Intermediate Equation	Equation 7)
K_3	:	Constant	DATA ENTRY
K_4	:	Constant	DATA ENTRY
γ_0	:	Low Pressure Ratio of Specific Heats	DATA ENTRY
A	:	Calibration Gas Constant (default 0.00281)	DATA ENTRY
t_2	:	Downstream Line gas Temperature in °C	MEASURED
d_b	:	Relative density of gas at base conditions	MEASURED

2.5.8.4 SARASOTA DENSITY TRANSDUCER INPUTS

The equations used for calculation of the Line density are as follows:-

1) $$\rho_a = d_0' \times \frac{(\tau - t_0')}{t_0'} \times \left[2 + K \times \left(\frac{(t - t_0')}{t_0'} \right) \right]$$

The value of line density is corrected for effects of temperature and pressure by the following equation.

2) $$t_0' = T_0 + Tempco \times (t_1 - T_{cal}) + Presco \times (p_1 - P_{cal})$$

3) $$d_0' = D_0 \times \left[1 - \left(\frac{VIBDEM \times \bar{R}}{\alpha \times \tau} \right)^2 \right]$$

4) $$\alpha = \left(\frac{\kappa \times p_l \times \bar{L}}{\rho_a} \right)^{1/2}$$

If $p_l = 0$ or $d_0' < 0.8\ D_0$ then $d_0' = D_0$

Where

ρ_a	:	Line Density of Gas in kg/m3	Equation 1)
d_0'	:	VOS corrected cal constant of spool in Kg/m3	Equation 3)
α	:	Calculation intermediate	Equation 4)
D_0	:	Calibration constant of spool in Kg/m3	DATA ENTRY
τ	:	Period of Densitometer in μS	MEASURED
t'_0	:	Corrected Calibration constant of Spool in μS	Equation 2)
K	:	Calibration constant of Spool in Kg/m3/°C	DATA ENTRY
T_0	:	Calibration constant of Spool μS	DATA ENTRY
Tempco	:	Temperature coefficient of spool in μS/°C	DATA ENTRY
Presco	:	Pressure coefficient of spool in μS/BAR	DATA ENTRY
VIBDEM	:	Characteristics of vibrating element in mm	DATA ENTRY
κ	:	Isentropic exponent of Gas	DATA ENTRY
t_1	:	Line Gas Temperature in °C	MEASURED
p_l	:	Line Gas pressure in Bar.a	MEASURED
T_{cal}	:	Calibration Temperature of Densitometer 15°C	DATA ENTRY
P_{cal}	:	Calibration Pressure of Densitometer 1.01325 Bara	DATA ENTRY

L	:	Speed of Sound factor 100000pa/Bar	DATA ENTRY
R	:	VOS correction to density 1000	DATA ENTRY

2.5.9 RELATIVE DENSITY TRANSDUCER INPUT

The relative density meter input to the Model 2000 is for a high frequency periodic type meter. It uses the same type of input as would be configured for a turbine pulse inputs and this is of the form of one periodic input signal with the following parameters.

Current input:	10mA.
Frequency range:	Up to 5kHz.

The basic equations used for calculation of the Relative density from this type of input is as follows:-

1) $$\mathbf{d_b = K_0 + (K_2 \times 10^{-6} \times T^2)}$$

2) $$\mathbf{\rho_n = \rho air_b \times d_b}$$

3) $$\mathbf{K_2 = \frac{G_x - G_y}{T_x^2 - T_y^2}}$$

4) $$\mathbf{K_0 = G_y - (K_2 \times T_y^2)}$$

Where

d_b	:	Relative density of gas at base conditions		Equation 1)
ρ_n	:	Normal Density of gas in kg/m3		Equation 2)
ρair_b	:	Density of air at base conditions in kg/m3		DATA ENTRY
K_0	:	Constant		DATA ENTRY
			or	(See Equation 4)
K_2	:	Constant		DATA ENTRY
			or	(See Equation 3)
T	:	Relative Density Transducer period in μ Seconds		MEASURED
G_x	:	Relative density of Calibration Gas x		DATA ENTRY
G_y	:	Relative density of Calibration Gas y		DATA ENTRY
T_x	:	Periodic Time of Calibration Gas x in μ Seconds		DATA ENTRY
T_y	:	Periodic Time of Calibration Gas y in μ Seconds		DATA ENTRY

When this type of input is selected for the measurement of relative density this measurement will take priority over any value received for relative density from a gas chromatograph.

2.5.10 SWITCH STATUS INPUTS

Each Input board fitted to the Model 2000 has three switch status inputs available. These inputs can have a pre-defined function as follows or they can be set to have no function and can be used purely for indication purposes for example to indicate the current status of a contact or voltage input to the Model 2000 either On (contact closed) or Off (contact open). The status of these inputs either On or Off is displayed on a separate page under the Line conditions, General option of the main menu. The current status can also be read or printed via any communication port set up for that purpose. Ratings of the inputs are identical to that for the Turbine switched inputs, a input de-bounce filter is fitted to these inputs.

The possible pre-set functions for each of the status inputs are as follows:-

No Function

This means that the input has not been assigned any pre set function its status will still be displayed and available for other indication, but it has no actual function.

Bi-Dir Turbine

In a Model 2000 set up for Pulse counting inputs from a Turbine Meter. The Status input is used to indicate flow direction to the Model 2000 if the meter used is capable of operating in both directions.

2.0 GENERAL DESCRIPTION

Enable +

In a Model 2000 set up for Pulse counting. The Status input is used to enable or disable the positive pulse count.

Enable –

In a Model 2000 set up for Pulse counting. The Status input is used to enable or disable the negative pulse count.

Print

This function uses the Status input as a local or remote Print operation input. If it is enabled then a second menu list appears which allows selection of a particular print job (as set up on the Print Job page) to be printed.

Sum

This function uses the Status input to Select Streams to be Summated from all the individual streams in a unit. If it is enabled then a menu list appears which allows selection of the streams to be summated under control of that Status input. If this function is enabled then the Sum function on the Station Values set-up page is disabled.

Ensonic Reset

This function uses the Status input to initiate an Ensonic Reset if such a gas measuring deice (Instromet Ensonic) is connected to the gas chromatograph port of the Model 2000.

Ensonic Calibration

This function uses the Status input to initiate an Ensonic Calibration if such a gas measuring deice (Instromet Ensonic) is connected to the gas chromatograph port of the Model 2000.

Security Switch 1

This function uses the Status input to replace Mode switch 1 when operating as a Security Switch On/Off. When this option is selected the internal Mode Switch 1 has no function.

Security Switch 2

This function uses the Status input to replace Mode switch 2 when operating as a Security Switch On/Off. When this option is selected the internal Mode Switch 2 has no function.

Oil Status

This function uses the Status input as a switch contact input, in conjunction with a turbine meter fitted with a Lubrication Oil level indication output.

Hold Counters

This function uses the Status input as a switch contact input to provide the Hold Counters function. The Model 2000 can be set to provide copies of the Main and Main Alarm Totals that can be stopped or Held by operating this function. These Totals in a Held position must be enabled in order to be viewed under the Main Menu item Totals.

Set Time

When a change of state from a logic 0 to a logic 1 is detected on this input then the contents of the Preset Time registers Preset hour, Preset minute and Preset seconds is copied to the current time for the M2000 clock.

Can Alarm

When a change of state from a logic 0 to a logic 1 is detected on this input then this indicates that the Grab Sampler can level alarm has been set. This will be either for Liquid Grab Sampler 1 or 2 which ever input has been configured for this function.

Under normal circumstances the polarity of the status inputs is as follows:-
Input open (logic 1) indicates forward +ve or normal flow
(also for a single flow direction)
Input closed (logic 0) indicates reverse or –ve flow.

It is possible to reverse the polarity of the input by selecting the tick box Invert adjacent to each input.

2.5.11 STATION PRESSURE AND TEMPERATURE INPUTS

The Station Pressure and Temperature inputs 1 and 2 are general purpose inputs for Pressure and Temperature they are available on all M2000 types and are intended for indication purposes only. They do not form any part of the flow calculations. Station Pressure and Temperature values can be displayed, printed etc. in the same way that all variable items can be.

2.5.11.1 STATION PRESSURE UNITS

The Units of station pressure used in the Model 2000 can be set to be either bar, Kpa, Kg/cm2 or psi in either absolute or gauge form.

2.0 GENERAL DESCRIPTION

In the case of analogue transmitters it is assumed that the 4-20mA current value is calibrated in the required units. However, in the case of HART transmitters the units value is read from the transmitter and compared against the value selected, if the value read does not agree with the value selected an accountable Unit alarm is raised.

If station pressure in absolute units is selected then all station pressure values must be entered and are displayed in absolute units.

If station pressure in gauge units is selected then all station pressure values must be entered and are displayed in gauge units except Patmos Mean atmospheric pressure, which must be entered and is displayed in absolute units.

2.5.11.2 STATION TEMPERATURE UNITS

The Units of Station Temperature used in the Model 2000 can be set to be either °C or °F.

In the case of analogue transmitters it is assumed that the 4-20mA current value is calibrated in the required units. However, in the case of HART transmitters the units value is read from the transmitter and compared against the value selected, if the value read does not agree with the value selected an accountable Unit alarm is raised.

2.5.11.3 HART TRANSMITTER STATION PRESSURE AND TEMPERATURE INPUTS

The Model 2000 is designed to be used with using the HART communications protocol. Typical transmitters are the Rosemount Model 3051C Pressure Transmitter and a Rosemount Model 3044/3144 Temperature Transmitter. All communication with the transmitters is done digitally and the analogue signals from the transmitters is set to the minimum value and therefore cannot be used for monitoring purposes.

WARNING:- The transmitters are connected in parallel as a multidrop system and each transmitter must have a different address.

It is essential that the transmitters have their addresses programmed and the burst mode operation turned off before they are connected to the Model 2000 Flow Computer. With Rosemount transmitters the Rosemount Smart Family Interface Model 268 is used for this purpose.

It is recommended that the pressure transmitter be programmed with a short address of 01 and the temperature transmitter with a short address of 02.

Refer to the Rosemount operating manuals for the programming procedures.

To interface with the hazardous area where intrinsically safe transmitters are used a digital safety barrier must be used a typical barrier is a Measurement Technology Ltd barrier Model MTL3046B or MTL 5042.

2.5.11.4 ANALOGUE TRANSMITTER STATION PRESSURE AND TEMPERATURE INPUTS

As an alternative to the HART transmitter inputs described in paragraph 2.5.10.3 the Model 2000 can also accept current input signals for Station Pressure and Station Temperature which are fed into an single sided amplifier and having a response time of approximately 470ms.

Input current:	4mA. to 20mA.
Input resistance:	100Ω

To interface with the hazardous area where intrinsically safe transmitters are used a safety barrier must be used.

2.5.11.5 STATION PRESSURE & TEMPERATURE SENSOR SCALING

The Model 2000 can also be configured so that each of the connected Station Pressure or Temperature Sensors can be scaled using a simple equation as follows:-

$$\mathbf{P_1Scale = Offset.1 + (R.1 \times P_1Tx)}$$

Where

P_1 Scale	Pressure P_1Scale is the used
R.1	Pressure P_1 Range Scaling Factor
Offset.1	Pressure P_1 Offset Scaling Factor
P_1 Tx	Pressure P_1 Actual measured

Identical Equations also apply for all Station Pressure and Temperature Sensor inputs.

2.5.12 SMART INDEX INPUT

The Model 2000 flow computer can be configured to receive a serial communication input from an Instromet SMART Index for Turbine meters. The input uses one of the communication ports configured for that purpose using the NAMUR serial communication protocol.

2.0 GENERAL DESCRIPTION

When used in this way the Model 2000 displays the received information from the SMART Index, it does not use it for any flow calculation purposes.

The Model 2000 will read and display the following Parameters from the SMART Index

	Meaning
a<US>	start character a, data frame identifier "meter-readout"
zzzzzzzzzzzzz<US>	meter readout max. 14 digits in ASCII Decimal, no suppression of leading zeros
ww<US>	indication of the dec. pt. of meter-readout max. 2 digits optional + or – and power of 10 in ASCII-Decimal Note 0, +0, -0 are equivalent and are all valid.
eee<US>	physical unit of meter readout, max. 3 characters as text e.g. m3
s<FS>	Device Status 1 byte 0x30 to 0x3F where 0x30 means no fault
b<US>	start character b, data frame identifier "identification"
	manufacturer code must be 3 capital letters e.g. INS
TTTTTT<US>	device type or meter class max. 6 characters as text e.g. G1600
SSSSSSSS<US>	serial number of the meter max. 9 characters as text e.g. 123456789
JJJJ<US>	year of manufacture of meter must be 4 digits in ASCII Decimal e.g. 2003
VVVV<FS>	software version number of Smart Index , max 4 characters as text
<US>	Unit separator
<FS>	File separator

For more detailed information relating to the setting up and configuration of the Instromet SMART Index see the operating instruction manuals for that device.

2.5.13 ANALOGUE INPUT FOR GRAB SAMPLER CAN LEVEL INDICATION

As an alternative to the Digital inputs described in paragraph 2.5.10 to indicate that a Grab Sampler Can is full the Model 2000 can also accept current input signals for sample can level indication this is fed into an single sided amplifier and having a response time of approximately 470ms.

Input current: 4mA. to 20mA.
Input resistance: 100Ω

To interface with the hazardous area where intrinsically safe transmitters are used a safety barrier must be used.

The Input is calibrated as a percentage of full indication and an alarm indication occurs when a preset level (percentage) is exceeded.

2.6 OUTPUT SIGNALS

2.6.1 ANALOGUE OUTPUT SIGNALS

Four analogue output signals are provided, on each fitted Output board, and these can be selected to be proportional to any of the items in the Line Conditions selection list. All are current output signals and can be selected to be either 0 to 20mA or 4mA to 20mA or 0 to 24mA by selecting the appropriate links for each output on the output board (See section 4.4 for link position details). The maximum load impedance that can be connected to an output to give 24mA is 500Ω. The minimum load impedance that can be connected to any output is 50Ω.

Associated with each output are the Maximum and Minimum scaling factors.

O/Px	selects the function of the output from the above list
O/Px mn	scales the min. output i.e. 0mA. or 4mA.
O/Px mx	scales the max. output i.e. 20mA. or 24mA.

2.0 GENERAL DESCRIPTION

Where x is the output numbered 1 to 4

The above scaling factors are entered in the same units as the output parameter for example, if the output has been selected to be Pressure then O/Px mn and O/Px mx are entered in the units of Pressure.

The values entered for O/Px mn and O/Px mx must be within the operating range of the parameter selected i.e. for Pressure between pmin and pmax. and the value entered for O/Px mn should be above or equal to pmin. and lower in value than pmax. Similarly O/Px mx should be above pmin. and O/Px mn and lower than or equal to pmax.

2.6.2 PID CONTROL ANALOGUE OUTPUT SIGNALS

This function can be used to control process variables like flow rate, temperature, pressure etc. Most PID functions use the difference between SP (Set point) and PV (Process Value) as input for its calculation. The output value is the sum of a Proportional, Integral and Derivative action. It has a forward / reverse parameter to use the controller in the right direction.

The output value will be the override value in manual mode. Manual (Override) / Automatic switch over will be carried out bumplessly.

For each output the following parameters must be set up Time Delay in seconds, SP Preset (Set point) value, Integral Time, Proportional Band and Derivative Time.

Calculations linking these parameters are as follows:-

$$P_{gain} = \frac{100}{P_{band}}$$

Epsilon, if "SP Control" is "As PV Control"

$$e_P = SP - PV$$

$$e_I = SP - PV$$

$$\Delta e_D = e_{P,n-1} - e_{P,n}$$

Epsilon, if "SP Control" is "Only I -action":

$$e_I = SP - PV$$

$$e_P = SP_{initial} - PV$$

$$\Delta e_D = PV_{n-1} - PV_n$$

When the PID controller is used in reverse mode:

$$e_P = -e_P$$

$$e_I = -e_I$$

$$\Delta e_D = -\Delta e_D$$

PID actions:

$$P_{action} = e_P \times P_{gain}$$

$$(I_{action,calc})_n = (I_{action})_{n-1} + e_I \times P_{gain} \times \frac{\Delta t}{T_i}$$

$$D_{action} = P_{gain} \times T_d \times \frac{\Delta e_D}{\Delta t}$$

$$Out_{calc} = P_{action} + I_{action} + D_{action}$$

Where

P_{gain}	= Proportional gain
P_{band}	= Proportional band
SP	= Set point
$SP_{initial}$	= Initial set point (= PV at start-up)

2.0 GENERAL DESCRIPTION

PV	= Process value
$PV_{,n}$	= Current Value of PV
$PV_{,n-1}$	= Previous Value of PV.
$e_{P,n}$	= Current Value of e_P
$e_{P,n-1}$	= Previous Value of e_P
e_P	= Epsilon for Proportional action
e_I	= Epsilon for Integral action
Δe_D	= Epsilon for Derivative action
P_{action}	= Proportional action
$I_{action,calc}$	= Calculated Integral action
I_{action}	= Finally used Integral action
D_{action}	= Derivative action
T_i	= Integration time
T_d	= Derivation time
Δt	= Last program cycle time
Out_{calc}	= Calculated Output value

When setting up PID Control Outputs the Analogue Outputs (See Analogue Outputs page) will need to be selected from the Analogue Outputs variable tree and dragged across to the appropriate output as described on the analogue outputs page.

2.6.3 SWITCHED OUTPUT SIGNALS

Twelve open collector switched outputs are provided, on each fitted Output board. These can be selected to be alarm outputs or pulse outputs proportional to total flows for telemetry purposes or valve or lubrication control outputs or grab sampler outputs.

All outputs are npn transistors and can be selected to be in a conducting or non-conducting state when the alarm is present. Each output is rated as follows:-

Transistor outputs (open collector)

Absolute Maximum continuous voltage	30Vdc.
Absolute Maximum continuous current	35mA.
Absolute Maximum continuous Power	100mW.

2.7 ALARMS, WARNINGS AND FAULTS

There are five categories of Alarms and Warnings :-

1) Accountable alarms
2) Non-accountable alarms
3) Temperature alarm
4) Fault alarm
5) Warnings

All types of alarm will illuminate the appropriate LED on the front panel, will be indicated on the Alarm display pages and can operate a digital transistor output provided that an output is available and has been set up for that purpose. Note that warnings, temperature alarms and non-accountable alarms will all cause the non-accountable LED to be illuminated. All accountable alarms will cause the accountable alarm LED to be latched ON this can only be cleared when the alarm has been reset and the alarm line is cleared from the Alarm display pages.

Details of all alarm identification is given in appendix 1.

2.7.1 ACCOUNTABLE ALARMS

The accountable alarm LED will remain latched ON after the alarm condition has been cleared, it can be switched OFF once the alarm condition has cleared by operating the accountable alarm clear function in the Alarm display pages. All Accountable alarms can be selected to operate an Accountable Alarm output if the unit is set-up to provide such an output.

2.7.1.1 GENERAL ACCOUNTABLE ALARMS

An accountable alarm will be indicated when any of the following conditions occur:-

1) Pressure sensor 1 is above the values of pressure.N max.
2) Pressure sensor 1 is below the values of pressure.N min.
3) There is no value for pressure sensor 1 pr1.N val.
4) A communications failure has occurred between the Model 2000 and pressure sensor 1 pr1.N hart.
5) Pressure sensor 1 is in a sensor generated alarm condition pr1.N hsts.

2.0 GENERAL DESCRIPTION

6) The selected pressure units do not match the units indicated by pressure sensor 1 pr1.N unit.
7) Pressure sensor 1 value is outside the deviation limit pr1.N dev.
8) Pressure sensor 1 value is outside the average deviation limit pr1.N adev.
9) Temperature sensor 1 is above the value of temp.N max.
10) Temperature sensor 1 is below the value of temp.N min.
11) There is no value for temperature sensor 1 te1.N val.
12) A comms failure has occurred between the Model 2000 and temperature sensor 1 te1.N hart.
13) Temperature sensor 1 is in a sensor generated alarm condition te1.N hsts.
14) The selected temperature units do not match the units indicated by temperature sensor 1 te1.N unit.
15) Temperature sensor 1 value is outside the deviation limit te1.N dev.
16) Temperature sensor 1 value is outside the average deviation limit te1.N adev.

NOTE In all cases above 1) to 16) the numeric character could be 1, 2 or 3 depending upon the number of selected multiple transmitters.

17) The serial check pressure is above the values of pressureN max.
18) The serial check pressure is below the values of pressureN min.
19) The serial check temperature is above the value of tempN max.
20) The serial check temperature is below the value of tempN min.
21) The uncorrected flow rate is above the value of Hi q. for more than 1 minute.
22) Base compressibility outside tolerance znN high or znN low.
23) Model 2000 is in Calibrate Mode.
24) Compressibility calculation cannot be completed Zn & Z will be set to 1.
25) Communication with the gas chromatograph has failed.
26) The gas chromatograph has a status alarm.
27) Modbus communication time out alarm.
28) Gas component xxxxx is above the max value for that component.
29) Gas component xxxxx is below the min value for that component.

NOTE xxxxx is up to 5 characters representing any of the gas components.

2.7.1.2 TURBINE ACCOUNTABLE ALARMS

If the Model 2000 is set-up for use with a Turbine Meter then the following alarm types can also occur:-
1) An hf turbine meter alarm (blade failure) has occurred turbN hf.

2.7.1.3 ULTRASONIC ACCOUNTABLE ALARMS

If the Model 2000 is set-up for use with an Ultrasonic Meter then the following alarm types can also occur:-

1) Wrong number of acoustic paths specified usN paths.
2) Meter security alarm bit set usN secur.
3) Reduced accuracy alarm usN level1.
4) Reduced accuracy alarm usNlevel2.
5) If an invalid floating point number has been received from the meter.
6) No valid communications from the meter for last 5 seconds usN comms.

2.7.1.4 DIFFERENTIAL PRESSURE ACCOUNTABLE ALARMS

If the Model 2000 is set-up for use with Differential pressure measurement across an orifice plate then the following alarm types can also occur, All differential pressure alarms will be indicated without sign for the positive or single direction and prefixed by a –ve sign for alarms on transmitters when the flow is in a negative or reverse direction:-

1) High range dp sensor 1 is above the value of dphi.N max.
2) High range dp sensor 1 is below the value of dphi.N min.
3) There is no value for high range dp sensor 1 dph1.N val.
4) A comms failure has occurred between the Model 2000 and high range dp sensor 1 dph1.N hrt.
5) High range dp sensor 1 is in a sensor generated alarm condition dph1.N hst.
6) The selected high range dp units do not match the units indicated by high range dp sensor 1 dph1.N unt.

7) High range dp sensor 1 value is outside the deviation limit dph1.N dev.
8) High range dp sensor 1 value is outside the average deviation limit dph1.N adev.
9) Low range dp sensor 1 is above the value of dplo.N max.
10) Low range dp sensor 1 is below the value of dplo.N min.
11) There is no value for low range dp sensor 1 dpl1.N val.
12) A comms failure has occurred between the Model 2000 and low range dp sensor 1 dpl1.N hrt.
13) Low range dp sensor 1 is in a sensor generated alarm condition dpl1.N hst.
14) The selected low range dp units do not match the units indicated by low range dp sensor 1 dpl1.N unt.
15) The low range dp sensor 1 value is outside the deviation limit dpl1.N dev.
16) Low range dp sensor 1 value is outside the average deviation limit dpl1.N adev.

NOTE In all cases above 1) to 16) the numeric character could be 1, 2 or 3 depending upon the number of selected multiple transmitters.

17) The high range serial check dp is above the value of dp hi N max.
18) The high range serial check dp is below the values of dp hi N min.
19) The low range serial check dp is above the value of dp lo N max.
20) The low range serial check dp is below the value of dp lo N min.

NOTE In all cases above the character N will refer to the stream number 1, 2 or 3.

2.7.1.5 DENSITY ACCOUNTABLE ALARMS

If the Model 2000 is set-up for use with a periodic measured Density or Relative Density input then the following alarm types can also occur:-

1) Density frequency High alarm (above 5000Hz) densN f hi.
2) Density frequency Low alarm (below 500Hz) densN f lo.
3) Rel. dens. frequency High alarm (above 5000Hz) rdN f hi.
4) Rel. dens. frequency Low alarm (below 500Hz) rdN f lo.

2.7.1.6 STATION ACCOUNTABLE ALARMS

If the Model 2000 is set-up for use with Station Pressure or Temperature inputs then the following alarm types can also occur:-

1) Station Pressure is above the values of S.prN max.
2) Station Pressure is below the values of S.prN min.
3) There is no value for Station pressure S.prN val.
4) A comms failure has occurred between the Model 2000 and Station pressure sensor S.prN hart.
5) Station Pressure sensor has a sensor generated alarm condition S.prN hsts.
6) The selected Station pressure units do not match the units indicated by Station pressure sensor S.prN unit.
7) Station Temperature is above the value of S.teN max.
8) Station Temperature is below the value of S.teN min.
9) There is no value for Station temperature S.teN val.
10) A comms failure has occurred between the Model 2000 and Station temperature sensor S.teN hart.
11) Station Temperature sensor has a sensor generated alarm condition S.teN hsts.
12) The selected station temperature units do not match the units indicated by Station temperature sensor S.teN unit.
13) Temperature sensor 1 value is outside the deviation limit te1.N dev.

NOTE In all cases above 1) to 13) the character N could be 1 or 2 depending upon the number of selected Station transmitters.

14) Station Controller Read of flow computer 1-5 failed.
15) Station Controller Write to flow computer 1-5 failed.
16) Station totals could not be calculated.
17) Station Controller Vb Comparison Alarm
18) Station Controller Vn Comparison Alarm

2.0 GENERAL DESCRIPTION

2.7.1.7 SMART INDEX ACCOUNTABLE ALARMS

1) Smart Index is not communicating.
2) Smart Index is sending invalid communication packets.

2.7.1.8 CORIOLIS METER ACCOUNTABLE ALARMS

1) Density Value received from Coriolis meter is above Density max. limit.
2) Density Value received from Coriolis meter is below Density min. limit.
3) Communication port used for Coriolis meter set up problem.
4) Communication failure or problem between FC2000 and Coriolis meter.
5) Units read from Coriolis meter different from those set in FC2000.
6) Coriolis Meter Status alarm.

2.7.1.9 GRAB SAMPLER ACCOUNTABLE ALARMS

1) Grab Sampler Can Full Alarm.
2) An attempt has been made to Reset the Grab Sampler whilst operating.
3) Grab Sampler Over speed alarm
   (Number of grabs per mass unit (at current flowrate) > max sampler speed)

2.7.2 NON-ACCOUNTABLE ALARMS

Indication of a Non–accountable alarm is given by the illumination of the non-accountable alarm LED on the front panel and by showing the alarm identification and time on the alarm pages of the LCD display.

2.7.2.1 GENERAL NON ACCOUNTABLE ALARMS

A non-accountable alarm will be indicated when any of the following conditions occur:-

1) The uncorrected flow rate is below the value of lo q.
2) The pressure used is above the values of prN high.
3) The pressure used is below the values of prN low.
4) The temperature used is above the values of teN high.
5) The temperature used is below the values of teN low.
6) The Station pressure used is above the values of S.prN high.
7) The Station pressure used is below the values of S.prN low.
8) The Station temperature used is above the values of S.teN high.
9) The Station temperature used is below the values of S.teN low.
10) The gas chromatograph is in a Cal or Idle state.
11) The gas chromatograph in not analysing.
12) Gas component xxxxx is above the high value for that component.
13) Gas component xxxxx is below the low value for that component.

2.7.2.2 TURBINE NON ACCOUNTABLE ALARMS

If the Model 2000 is set-up for use with a Turbine Meter then the following alarm types can also occur:-

1) An If turbine meter alarm (blade failure) has occurred turbN If.

2.7.2.3 ULTRASONIC NON ACCOUNTABLE ALARMS

If the Model 2000 is set-up for use with an Ultrasonic Meter then the following alarm types can also occur:-

1) Meter path 1 efficiency is below pre-set % limit usN eff.1%.
2) Meter path 2 efficiency is below pre-set % limit usN eff.2%.
3) Meter path 3 efficiency is below pre-set % limit usN eff.3%.
4) Meter path 4 efficiency is below pre-set % limit usN eff.4%.
5) Meter path 5 efficiency is below pre-set % limit usN eff.5%.
6) Meter has sent a path Status alarm
7) Meter is configured for incorrect units.

2.7.2.4 DIFFERENTIAL PRESSURE NON ACCOUNTABLE ALARMS

If the Model 2000 is set-up for use with Differential pressure measurement across an orifice plate then the following alarm types can also occur, All differential pressure alarms will be indicated without sign for the positive or single direction and prefixed by a –ve sign for alarms on transmitters when the flow is in a negative or reverse direction:-

2.0 GENERAL DESCRIPTION

1) High range dp sensor 1 is above the value of dphi.N hi.
2) High range dp sensor 1 is below the value of dphi.N lo.

NOTE In all cases above 1) to 2) the numeric character could be 1, 2 or 3 depending upon the number of selected multiple transmitters.

NOTE In all cases above the character N will refer to the stream number 1, 2 or 3.

2.7.2.5 DENSITY ACCOUNTABLE ALARMS

If the Model 2000 is set-up for use with a periodic measured Density input then the following alarm types can also occur:-

1) Density value is above the High alarm limit densN hi.
2) Density value is below the Low alarm limit densN lo.
3) Density values are in deviation.
4) Relative Density values are in deviation.

2.7.2.6 SMART INDEX NON ACCOUNTABLE ALARMS

Alarm Related to the use of the Model 2000 with a Smart Index.

1) Smart Index Reset type 1
2) Smart Index Reset type 2
3) Smart Index Ram fail type 2
4) Smart Index Ram fail type 3
5) Smart Index Magnetic wire failure
6) Smart Index Namur Interface failure
7) Smart Index EEPROM Failure
8) Oil Level Alarm (Status Input)

NOTE In all cases above the character N will refer to the stream number 1, 2 or 3.

2.7.2.7 CORIOLIS METER NON ACCOUNTABLE ALARMS

1) Deviation Alarm between Serial Flow Value and Pulse Input Value

2.7.2.8 GRAB SAMPLER NON ACCOUNTABLE ALARMS

1) Grab Sampler Production period has expired.
2) Grab Sampler Can fill warning.
3) Grab Sampler Deviation Alarm
   Deviation between the actual fill level and the estimated/calculated fill level
4) Grab Sampler Sample rate alarm.

2.7.3 TEMPERATURE ALARM

A separate non accountable temperature alarm tempN alrm can occur if all of the following conditions occur:-

1) The temperature is below t-alarm and
2) The uncorrected flow rate is above the value of Lo q. and
3) The temperature has been below t-alarm for a programmable time.

NOTE In all cases above the character N will refer to the stream number 1, 2 or 3.

2.7.4 FAULTS

The Model 2000 Flow Computer provides continuous self checking during operation. In normal operation the self checking routine tests all the memory components for data corruption. A watchdog circuit is also provided to detect failure of critical components such as the processor.

Faults will be indicated for each user board position that contains a board that is either faulty i.e. non functioning or is a critical board but is missing or is the wrong type of board. All faults will cause the Model 2000 to halt flow calculation and to wait for the defective board to be rectified. When a fault occurs the fault LED is illuminated and the fault identification is shown on the alarm pages of the LCD display. The following are the types of fault that will be indicated:-

2.0 GENERAL DESCRIPTION

1)	Faulty or missing Input board in user position X.	Fault ipX
2)	Faulty or missing Output board in user position X.	Fault opX
3)	Faulty or missing Communication board in user position X.	Fault comX
4)	Faulty or missing Network board in user position X.	Fault netX
5)	Wrong board type in user position X.	Fault brdX
6)	No or incomplete data for operation	Fault data
7)	Real Time Clock Fault or failure	Fault rtc

NOTE In all cases above the character X will refer to the user slot position 1, 2, 3, 4 or 5 (See Figure 2 for slot position details).

2.7.5 WARNINGS

Warnings will be indicated for each user board position that contains a board that is a non-critical board and is missing or is the wrong type of board. All warnings will not stop the Model 2000 from calculating flow values. Additionally warnings will be indicated when any of the pulse outputs are in an over range state. The following are the types of warning that will be indicated:-

1)	Missing Input board in user position X.	Warn ipX
2)	Missing Output board in user position X.	Warn opX
3)	Missing Comms. board in user position X.	Warn comX
4)	Wrong board type in user position X.	Warn brdX
5)	Pulse Output M on O/P Bd. in position X is Over range	opM brdX
6)	Model 2000 is set to be in Maintenance mode	Err Maint.
7)	Model 2000 is set to be in Proving mode	proving
8)	Model 2000 analogue input calibration is set to Default	CalDefault
9)	Serial Port Handshaking line CTS pending timeout.	Warn ctsX.Y
10)	A Divide by zero has occurred	Div zero

NOTE In all cases above the character X will refer to the user slot position 1, 2, 3, 4 or 5 (See Figure 2 for details).

The character Y will refer to the communication port 1 is the upper port and 2 is the lower port

The character M will refer to the Digital output 1 to 12.

2.7.6 HIGH AND LOW FLOW ALARMS

A high flow alarm is given if the uncorrected flow rate (or d.p. in the case of orifice plate operation) exceeds the value entered in memory for Hi q for more than 1 minute.

A low flow alarm is given if the uncorrected flow rate (or d.p. in the case of orifice plate operation) falls below the value entered for Lo q.

Both Hi q and Lo q are entered as a % of maximum line flow (Qmax).

When an alarm occurs the Hi/Lo flow LED (Yellow) is illuminated on the front panel, a low or high flow identification is shown on the alarm pages of the LCD display. A Hi q alarm is defined as an accountable alarm and Lo q as a non-accountable alarm.

2.8 PULSED OUTPUTS FOR TOTAL FLOWS

If any of the twelve transistor pulse outputs that are available from each fitted Output Board are selected to be a pulse output proportional to totals for telemetry purposes , then the available outputs are as follows:-

For Model 2000 set up for Turbine Meter Inputs

1)	Total uncorrected volume from the monitor input.	+Vbm
2)	Total uncorrected volume from the high frequency input.	+Vb
3)	Total uncorrected volume from the high frequency input Un-haltable counter.	+Vbu
4)	Total uncorrected volume from the high frequency input corrected for meter linearity.	+Vbc
5)	Total uncorrected volume from the high frequency input corrected for meter linearity Un-haltable counter.	+Vbcu
6)	Total corrected volume from the high frequency input.	+Vn
7)	Total corrected volume from the high frequency input Un-haltable counter	+Vnu

2.0 GENERAL DESCRIPTION

8)	Total energy flow calculated from either Hs. or Hi.	+E
9)	Total energy flow calculated from either Hs. or Hi. Un-haltable counter	+Eu
10)	Total mass flow.	+M
11)	Total mass flow Un-haltable counter.	+Mu

For Model 2000 set up for Ultrasonic Meter Inputs

1)	Total uncorrected volume from the meter input.	+Vb
2)	Total uncorrected volume from the meter input Un-haltable counter.	+Vbu
3)	Total uncorrected volume from the meter input corrected for linearity, pressure and temperature expansion.	+Vbc
4)	Total uncorrected volume from the meter input corrected for linearity, pressure and temperature expansion Un-haltable counter.	+Vbcu
5)	Total corrected volume.	+Vn
6)	Total corrected volume Un-haltable counter	+Vnu
7)	Total energy flow calculated from either Hs. or Hi.	+E
8)	Total energy flow calculated from either Hs. or Hi. Un-haltable counter	+Eu
9)	Total mass flow.	+M
10)	Total mass flow Un-haltable counter.	+Mu

For Model 2000 set up for Orifice plate operation

1)	Total mass flow.	+M
2)	Total mass flow Un-haltable counter.	+Mu
3)	Total mass flow corrected for non linearity.	+Mc
4)	Total mass flow corrected for non linearity Un-haltable counter.	+Mcu
5)	Total corrected volume.	+Vn
6)	Total energy flow calculated from either Hs. or Hi.	+E
7)	Total energy flow calculated from either Hs. or Hi. Un-haltable counter	+Eu

For Model 2000 set up for Wet Gas Venturi machines type 1

1)	Mass gas from Venturi no correction for wet gas	+Mguc
2)	Mass gas from Venturi corrected for wet gas	+Mgc
3)	Mass liquid corrected	+Mlc
4)	Line Volume of gas	+Ngl
5)	Base Volume of gas	+Ngb
6)	Line Volume of Liquid	+Nll
7)	Line Volume of Liquid	+Nlb
8)	Mass of Water	+Mw
9)	Mass of Condensate	+Mc

All the above Venturi Totals are also available in un-haltable versions

For Model 2000 set up for Wet Gas Venturi machines type 2

1)	Mass gas from Venturi no correction for wet gas	+Mguc
2)	Mass saturated gas from Venturi corrected for wet gas	+MgS
3)	Mass dry gas from Venturi corrected for wet gas	+MD
4)	Mass liquid corrected	+ML
5)	Mass two phase product including Water	+MTP
6)	Mass condensate liquid corrected	+MC
7)	Mass Water liquid corrected	+MW

2.0 GENERAL DESCRIPTION

8)	Mass Methanol liquid corrected	+MM
9)	Mass Hydro Carbon corrected	+Mhc
10)	Standard Volume of gas	+VnG
11)	Standard Volume of condensate	+VnC
12)	Standard Volume of Water	+VnW
13)	Energy	+E

All the above Venturi Totals are also available in un-haltable versions

For Model 2000 set up for Coriolis meter machines

1)	Mass of Liquid in kg primary source.	+Ml
2)	Mass of Liquid in kg secondary source.	+Mls
3)	Volume of Liquid at Line conditions in m3	+VGl
4)	Volume of Liquid at base conditions in m3	+VNl
5)	Mass of Water in kg.	+Mw
6)	Volume of Water at Line conditions in m3	+VGw
7)	Volume of Water at base conditions in m3	+VNw
8)	Mass of Condensate in kg.	+Mc
9)	Volume of Condensate at Line conditions in m3	+VGc
10)	Volume of Condensate at base conditions in m3	+VNc

All the above Coriolis Totals are also available in un-haltable versions

Primary and secondary source from the Coriolis meter can be either serial data via Modbus communication or pulse accumulation via pulse input.

For All Model 2000 types if enabled

1)	Mass of CO2	+CO2

Each of the above totals (not the Un-haltable counters) is available for normal flows as listed and for Error (or Alarm) flows. They are available for each a fitted stream and for the sum of the streams if available. If the Model 2000 is set-up to use a Bi-directional Turbine meter or Ultrasonic meter input then all totals are also available in both forward (+) direction or reverse (-) direction.

The pulse outputs for total flows are scaled using factors tof where each pulse equals the unit of tof. i.e. if tof is set to 100 each pulse equals 100 units.

The maximum frequency and duty cycle of the pulsed outputs can be pre-set as can the conducting or non conducting state of the transistor output.

2.9 PULSED OUTPUTS FOR CONTROL FUNCTIONS

Any of the twelve transistor pulse outputs that are available from each fitted Output Board can be selected for the following control type functions:-

2.9.1 FLOW DIRECTION OUTPUT

The required output can be set to indicate Flow Direction it will indicate the flow direction as determined by the sign of the flow rate parameter and the Invert function e.g.(On) for + direction or (Off) for – direction.

2.9.2 FIXED OUTPUT

The required output can be set to be Fixed i.e. it is set permanently to be Logic 1 (On) or Logic 0 (Off)

2.9.3 DIGITAL INPUT STATUS OUTPUT

The required output can be set to indicate the current status of any of the Digital Switched Inputs 1 , 2 or 3 (on each fitted Input Board) Logic 1 Input is (On) or Logic 0 Input is (Off). The Invert function will reverse these outputs.

2.9.4 VALVE CONTROL OUTPUT

2.0 GENERAL DESCRIPTION

The required output can be set to control the Open and Close Functions of one or two external Valves under remote control using a Modbus serial communication port.

The Valve Control Output will be energises for a preset time interval of between 1 and 65535 seconds as set using the operating software.

The Invert function will reverse these outputs.

If the Value 255 is written then the Output is set ON permanently.

If the Value 254 is written then the Output is set OFF permanently.

2.9.5 OIL LUBRICATION CONTROL OUTPUT

The required output can be set to operate a Lubrication control function on a Turbine Meter fitted with such a control pump device.

The following parameters can be set to alter the duration and number of control pulses sent to the lubrication pump.

Lubrication O/P based on time (days) or Volume, selectable for Vb, Vbu or Vn (m3).
Minimum flow rate (qb) can be set to avoid lubricating below this level.
Configurable number of O/P pulses to be generated to allow multiple pump strokes.
O/P pulse duration can be set from 1 to 250 seconds.
Pause time (in between multiple pulses) can be set (as above) to allow for pump refill-time.

2.9.6 GRAB SAMPLER OUTPUT SIGNALS

The FC2000 can provide outputs to be used with two identical sized sample cells. The operation of these grab samplers will be controlled by the FC2000 flow computer, with the possibility of allowing remote monitoring, start-, stop- and reset-functionality. The FC2000 flow computer shall collect representative samples simultaneously or individual for both samplers. The sample frequency is calculated via operator entered set points so that it is proportional to the flow rate. Continuous indication of the current sample volume collected shall be provided, an alarm will be indicated when the cylinder level reached the Cylinder Alarm level which is set to a default value of 80% full.

2.9.6.1 GRAB SAMPLER OUTPUT OPERATION

Start/Stop Sampling

Both grab sampler systems can be started or stopped individually or at the same time. This can either be done manually via the FC2000 display in “EDIT” mode or automatically from a remote system. On start-up of the FC2000 flow computer the sampling system will be stopped on both samplers, and must be started manually by the operator.

Sampling will be disabled automatically under the following conditions:

The flow rate is below an operator entered limit.(low flow cut-off)
The sample can is full.
When the entered production period has expired.

If sampling is stopped manually by the operator it will not re-start automatically, but must be started manually.

Configuration Settings

The following fixed values shall be entered by the operator.

Cylinder size (ml or cc)
Cylinder Full alarm (%)
Cylinder Alarm (%)
Grab Size (ml or cc)
Grab output Pulse Duration (seconds)
Deviation between calculated and measured cylinder level (%)
Large Max sampler speed (grabs/tonnes)
Large Expected Production quantity in (tonnes)
Production period (days) or
Start/Stop date
Automatically resume sampling after low flow cut off.

The operator can only modify the cylinder size, grab size and output pulse duration samples if no sampling is in progress and the volume in the cylinder has been reset.

The operator can modify the expected production and sample pulse duration to allow for changes in flow during the production period.

2.0 GENERAL DESCRIPTION

Sample Cylinder Reset

Whenever a sample cylinder is physically emptied, the operator should reset the displayed volume to zero. The operator can only reset the cylinder volume if no sampling is in progress. When the cylinder volume is reset the grab count is also reset to zero.

Sample Cylinder Full Detection

The Flow computer monitors the fill level of each sampler with an analogue level indicator (4-20 mA) See paragraph 2.4.11 or with a digital switch input see paragraph 2.4.12. When flow rates have changed during the specified period and the total exceeds the operator entered expected total, the sampling will be stopped as soon as the cylinder level exceeds the Cylinder full alarm (default 95%). An alarm will be raised when the cylinder level exceeds the Cylinder Alarm level (default 80%).

2.0 GENERAL DESCRIPTION

2.9.6.2 GRAB SAMPLER CALCULATIONS

The sampling is flow proportional, but will be ended at the end of the specified period. To organize this flow proportional sampling, the expected liquid total for that period, the cylinder and grab size must be entered by an operator. The following equations will then calculate when a sample needs to be taken.

$$\textbf{Number of Samples} = \frac{\textbf{Cylinder Size} \times \textbf{Fill Limit} \times \textbf{0.01}}{\textbf{Grab Size}} \quad (1)$$

$$\textbf{Remaining Samples} = \textbf{Number of Samples} - \textbf{Taken Samples} \quad (2)$$

$$\textbf{Mass flow between Samples} = \frac{\textbf{Expected Liquid Total}}{\textbf{Number of Samples}} \quad (3)$$

$$\textbf{Estimated Volume} = \frac{\textbf{Taken Samples} \times \textbf{Grab Size}}{\textbf{Cylinder Size}} \times \textbf{100} \quad (4)$$

$$\textbf{Remaining Volume} = \textbf{Fill Limit} - \textbf{Actual Volume} \quad (5)$$

$$\textbf{Sample Rate} = \frac{\textbf{Grab Size}}{\textbf{Expected Liquid Total}} \quad (6)$$

Where:

Number of Samples :	Number of samples to fill the sample cylinder to 80%	Equation 1
Cylinder Size :	Size of cylinder in ml or cc	Data Entry
Grab Size :	Size of the sample plunger in ml or cc	Data Entry
Fill Limit :	Limit of cylinder used for filling	Data Entry
Remaining Samples :	Number of grabs to fill the sample cylinder	Equation 2
Taken Samples :	Counter of the samples taken by the FC	Measured
Mass flow between Samples :	Mass flow counted between two samples	Equation 3
Expected Liquid Total :	Expected period total	Data Entry
Estimated Volume :	Current calculated volume in the sample cylinder	Equation 4
Remaining Volume :	Remaining volume required to fill the sample cylinder	Equation 5
Actual Volume :	Current volume in the sample cylinder	Measured
Sample Rate :	Number of grabs taken per mass unit	Equation 6

2.0 GENERAL DESCRIPTION

2.10 COMMUNICATIONS PORTS

The Model 2000 has as standard two communication ports operating to the RS232 or RS485 communication standard. Each port can be set up to have separate settings for Baud rate, parity, start and stop bits and handshaking.

These ports can be set to function as any of the following:-

Modbus ASCII	communication port for reading and writing of data.
Modbus RTU	communication port for reading and writing of data
Password Modbus ASCII	communication port for reading and writing of data. Security controlled by password.
Password Modbus RTU	communication port for reading and writing of data. Security controlled by password.
Instromet Ultrasonic 1	communication port for receiving data from a connected Instromet US meter using the Uniform communication protocol.
Instromet Thru-port 1	communication port for use with an Instromet US meter using UNIFORM Software.
Instromet Ultrasonic Modbus RTU 1	communication port for receiving data from a connected Instromet US meter via Modbus RTU communication rather than Uniform protocol..
ABB Totalsonic Modbus RTU 1	communication port for receiving data from a connected ABB Totalsonic US meter via Modbus RTU communication protocol.
Panametrics GM868	communication port for receiving data from a connected Panametrics GM868 US meter via Modbus RTU communication protocol.
Daniels Senior Sonic	communication port for receiving data from a connected Daniels Senior Sonic US meter via Modbus RTU communication protocol.
Printer	communication port for connection to an external serial printer.
Chromat ASCII	communication port for connection to a Gas Chromatograph using ASCII Modbus.
Chromat RTU	communication port for connection to a Gas Chromatograph using RTU Modbus.
OSC-01-E	communication port to read gas data via OSC-01-E protocol
Station Controller	communication port for connection from a Station Controller to a Flow Computer.
Smart Index	communication port for receiving data from a connected Instromet Smart Index.
ASCII Micro Motion RFT9739 stream 1	communication port for receiving data from a connected Micro Motion Coriolis meter type RFT9739 using Modbus ASCII protocol. (See appendix 5 for data to be read).
No Function	No function is set-up for this port.

2.0 GENERAL DESCRIPTION

Two additional communication ports can be added to the M2000 by including a Comms Board (two serial ports per board).

2.11 INPUT 2 BOARD

When fitted the Input 2 Board ASSY2000-3-099 can be configured for three different uses as follows:-

Normal Input Board This function assumes operation for gas measurement where all input functions, from pulse generating devices, such as Turbine meters, and all Status input as well as all transducer measurements are defined by the operator and no pre-determined functions are defined.

Liquid Meter Input Board This functions assumes that the Model 2000 flow computer is connected to a Liquid Turbine Meter with two inputs A and B this function is preset and cannot be altered by the operator. This function is not defined in this manual see Manual type M2000-230.

Prover Input Board This function assumes that the Model 2000 Prover flow computer is connected to other flow computer prove outputs and prover loop switch functions. This function is not defined in this manual see Manual type M2000-230.

Input 2 Boards are provided with two status LEDS on the top edge adjacent to the motherboard connector with the following functions

LED 1	LED2	Function
Fast Flash	On	Dual Port memory fault
Fast Flash	Off	Programmable device fault
Off	Fast Flash	ADC Device Fault
Slow Flash	On	Hart Loop 1 problem
On	Slow Flash	Hart Loop 2 problem
Slow Flash	Slow Flash	All functions OK
Fast Flash	Fast Flash	Unknown state

All other state combinations have no function.

2.0 GENERAL DESCRIPTION

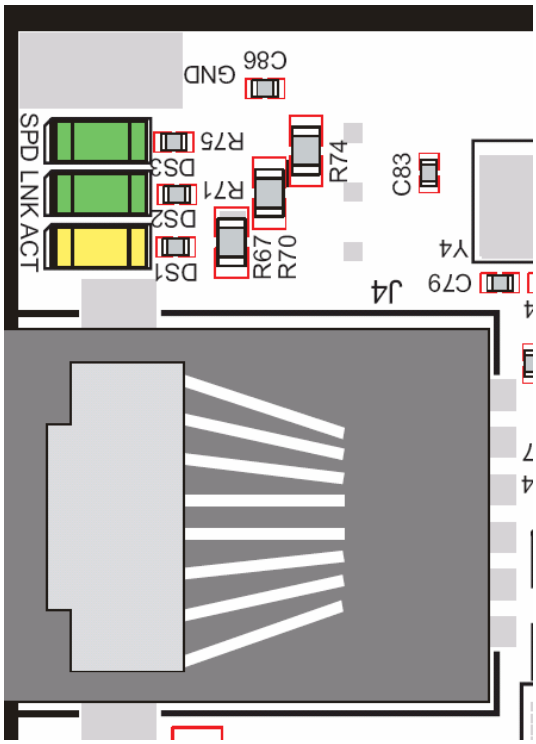
2.12 NETWORK 2 COMMUNICATION BOARD

The Model 2000 can as an option be fitted with an Ethernet networking board, to enable selected data items to be read via a Network connection. The Network Board can be placed in any of the user board slot position, its functions can be enabled and set-up using the M2000 Windows software Ethernet Access options.

The M2000 Network 2 card operates at the 10/100MHz speed connection is made via a standard 8 pin RJ45 connector. Correct connection to a Network and communication is indicated by two green and one yellow LED indicators :-

LNK	indicates connection to an Ethernet link
ACT	indicates Ethernet activity
SPD	indicates connection to a functioning 100Base-T network .

Dimensional and other information is shown in Figure 14.



2.13 COUNTER MODULE

An external electromechanical counter unit with up to four counters is available as an accessory to the Model 2000.

2.14 PRINTER FACILITY

An external serial printer is available as an accessory to the Model 2000.

2.15 POWER SUPPLY +24V dc OPERATION

The nominal +24 Vdc supply is connected to a terminal block located on the rear panel. Adjacent to the terminal block is a fuse rated at 3.15A. The Model 2000 will accept supply voltages in the range +21 Vdc. to +28 Vdc. An auxiliary power output terminal block is also available on the rear of the Model 2000 this fused separately with a 1.6A fuse.

3.0 INSTALLATION, INITIALISATION & CALIBRATION

SECTION 3

3.0 INSTALLATION, INITIALISATION & CALIBRATION

3.1 MECHANICAL INSTALLATION

The outline chassis dimensions are given in figure 3 and provide for mounting in either a panel or standard rack. Under normal ambient conditions no special ventilation requirements are necessary. Where the Model 2000 may be subject to high ambient temperatures- e.g. near heat producing apparatus or in direct strong sunlight. Adequate ventilation should be provided. The operating environment should be clean, dry and free from a corrosive atmosphere.

3.2 ELECTRICAL INSTALLATION

3.2.1 POWER SUPPLY

A power supply with a dc. voltage of between 21 V and 28 V is connected to the terminal block on the rear panel of the Model 2000 ensuring that the polarity is as marked. Ensure that a 3.15A fuse is fitted in the fuse holder located above the terminal block. See figure 2 for details.

The Model 2000 Flow Computer must be connected to a suitable Ground or Earth Connection via the Earth Stud located at the rear of the chassis. See Figure 2 for details.

3.2.2 TRANSMITTER INPUT CONNECTIONS

The input transmitter circuits are connected to the Model 2000 via the 32 way terminal connections on the rear panel of the Model 2000. Before any of the transmitters are connected reference should be made to the instrument instruction manuals applicable to the individual transmitters.

WARNING:

IN HAZARDOUS ENVIRONMENTS A TRANSMITTER MUST BE CONNECTED IN ACCORDANCE WITH THE SAFETY CERTIFICATE CONDITIONS SPECIFIED FOR THE INDIVIDUAL TRANSMITTER.

3.2.3 HART TRANSMITTER INPUT CONNECTIONS

The Hart transmitters are connected in parallel as a multidrop system and each transmitter must have a different address.

It is essential that the transmitters have their addresses programmed and the burst mode operation turned off before they are connected to the Model 2000 using the Rosemount Smart Family Interface Model 268 or similar interface.

All transmitters on the same Hart Loop must be assigned different short addresses it is recommended that the pressure transmitter must be programmed with a short address of 01 and the temperature transmitter with a short address of 02.

Refer to the Rosemount operating manuals for the programming procedures.

To interface with the hazardous area Measurement Technology Ltd barrier types Model MTL3046B and Model MTL 5042 are recommended to be used.

Methods of connecting transmitters are given in figure 18 and 22 and the connector pin designations are given in Appendix 4.

3.2.4 OUTPUT SIGNAL CONNECTIONS

The output signal connections are via the 32 way terminal on the rear panel and the connector pin designation is given in Appendix 4.

3.3 INITIALISATION

3.3.1 INTERNAL SWITCHES

Before the Model 2000 can be operated it is necessary to set the internal mode switches to the required positions.

To gain access to the mode and security switches remove the small plastic cover on the left hand side of the Model 2000 (As shown in figure 16). When setting the switches, care should be taken to minimise the handling of any circuit board within the Model 2000 to avoid the possibility of any electrostatic damage to the integrated circuits.

3.3.2 SETTING THE INTERNAL SWITCHES

Each mode switch is set by pushing the coloured slider to the position required. The functions are given below:-

Normal RUN mode:-

3.0 INSTALLATION, INITIALISATION & CALIBRATION

Switch No.	ON	OFF
1	Security 1 Off	Security 1 On
2	Security 2 Off	Security 2 On
3	Run Mode	
4	Backup Battery On	Backup Battery Off

3.3.3 OPERATION

For initial operation the internal mode switches should be set as above with the security switches set to the OFF position.

The power to the Model 2000 is switched on, the main Model 2000 display will indicate a start up message. This will indicate if the Model 2000 is capable of operating and has sufficient data or requires data and set-up to be initialised.

Initialisation and Set-up of a Model 2000 is achieved using the operating PC software for the Model 2000 in conjunction with an Infra red communication adapter and the communication port on the front of the Model 2000. In its default mode the Model 2000 communication set-up is as follows:-

Comms id of 0

Baud rate of 38400

Most IrDa communication adapters will normally initially operate at the default baud rates of 9600.

Selected types of IrDa adapter can be set to operate at higher baud rates by using the Main Menu SYSTEM option (See paragraph 2.3.10).

The supported types are:-

BS Instruments Ltd Type 2000-3-070 Fixed baud rate of 38400
(See Figure 21 for details)

Parallax Research PRA 9500C Up to 115k baud

Once the PC system has been initialised and the operating software started, the Infra red adapter should be positioned within 1-2 metre's from the Model 2000 communication port in direct line of sight.

The instructions on the operating software for setting up and programming should be followed.

As an alternative to the Infra Red Cable that has to be connected to a COM X port of the PC a USB terminated device is also available.

BS Instruments Ltd Type 2000-3-075 Fixed baud rate of 38400

Use of this device requires appropriate Software Drivers to be installed on the operating PC. These are supplied with the Cable complete with installation instructions.

Model 2000 Units supplied after the end of 2004 will be equipped with a USB type “A” connection on the front panel replacing the Infra Red Window. In this case connection to a PC is achieved by using an A to A USB cable, this is supplied with the Model 2000.

Use of this device requires appropriate Software Drivers to be installed on the operating PC. These are supplied with the Cable complete with installation instructions.

See figures 24 and 25 for details.

3.4 SOFTWARE INSTALLATION

If it becomes necessary to update or re-install the operating software inside the Model 2000 the mode switches should be set as below.

Explicit instructions for this function are given in a Technical Manual separate from this manual and should only be carried out by personnel familiar with the function.

Programming Boot mode

3.0 INSTALLATION, INITIALISATION & CALIBRATION

Switch No.	ON	OFF
1	Security 1 Off	Security 1 On
2	Irda Infra Red or Front Panel USB Connector	Rear Connector Skt 1
3		Boot Mode
4	Backup Battery On	Backup Battery Off

3.5 CALIBRATION

3.5.1 INPUT SIGNALS

3.5.1.1 DIGITAL INPUT SIGNALS

The Model 2000 Flow Computer does not require calibrating for any of the pulse inputs from meters as these inputs use a digital format.

3.5.1.2 HART INPUT SIGNALS

The Hart pressure and temperature transmitters must be calibrated themselves in accordance with the manufacturers instructions. The transmitters are connected to the Model 2000 in parallel as a multidrop system and each transmitter must have a different address.

It is essential that the transmitters have their addresses programmed and the burst mode operation turned off before they are connected to the Model 2000. Use the Rosemount Smart Family Interface Model 268 to programme and calibrate the transmitters referring to the Rosemount operating manuals for the programming procedures.

It is possible to Calibrate the Hart transmitters once they are in use these is done using the Calibrate Main menu option. This menu item when selected will allow access to the Input parameters that will require calibration via the Keyboard and Display of the Model 2000.

When this menu item is selected the user will be prompted to enter a four digit numeric password, to gain access to the calibration pages. It is possible to set-up a maximum of three different passwords and each of these passwords can be set to allow access or not to the calibration pages, these passwords are the same as used in the EDIT mode.

In its factory default condition the three available passwords are 1111, 2222 and 3333.

Once the password has been entered and accepted a calibration sub menu will appear as follows:-

Outputs	Selects calibration of any Analogue output.
Analogue	Selects calibration of any Analogue input.
Hart	Selects calibration of any Hart Loop input.
Exit	Returns operation to the Main Menu.

Each Hart input calibration page relates to a specific Hart Loop the position of the loop will be shown on the top left hand corner of the calibration page and will refer to SLOT 1 to 5 defining the User board positions (See figure 2 for positions) and Loop 1 or 2 (See appendix 4 for connections). The Hart Calibration page will show all transmitters (up to 3) currently configured for that loop and the process variables and units being read from them. The Calibration page will allow the communication to the Hart transmitters to be switched ON (Normal condition) or to be switched OFF (Calibrate condition) So that a Hart loop calibrator can be connected to the system and each of the connected transmitters calibrated or checked.

NOTE it is not possible to individually turn off the transmitters on one loop , all must be either ON or OFF.

The user can go on to calibrate as many Hart or Analogue input parameters as are required. Once all the changes are complete the user can Exit the EDIT section by selecting the function key EXIT. Selecting the EXIT function will prompt with a EXIT menu as follows:-

3.0 INSTALLATION, INITIALISATION & CALIBRATION

Exit & Save	Exit the calibration mode, save the changes to memory and use the new values.
Exit & No Save	Exit the calibration mode, do not action any of the changes made.
Undo	Do not exit calibration mode and undo all previous changes in this session.

Any HART loop left in the OFF state when exiting the Calibrate mode will automatically be switched ON when the unit is returned to the running condition.

3.5.1.3 ANALOGUE INPUT SIGNALS

The Analogue input signals to the Model 2000, normally used for pressure, temperature, selected gas data or dp will require calibration as follows:-

The active input signals to the Model 2000 are calibrated by using the keyboard to enter the calibration data. The Model 2000 display shows the parameters to be entered and the scroll keys can be used to step through the calibration parameters from start to finish to ensure all of the calibration data is entered.

NOTE: If a routine calibration check is being carried out, the scroll keys can be used to select the parameter which is required for checking passing through other parameters.

Calibration of the temperature inputs when platinum resistance thermometers are used must be carried out with any zener barriers in the circuit to avoid errors due to differing barrier resistance.

When the CALIBRATION menu item is selected the user will be prompted to enter a four digit numeric password, to gain access to the calibration pages. It is possible to set-up a maximum of three different passwords and each of these passwords can be set to allow access or not to the calibration pages

In its factory default condition the three available passwords are 1111, 2222 and 3333.

Once the password has been entered and accepted a calibration sub menu will appear as follows:-

Outputs	Selects calibration of any Analogue output.
Analogue	Selects calibration of any Analogue input.
Hart	Selects calibration of any Hart Loop input.
Exit	Returns operation to the Main Menu.

Each Analogue input calibration page relates to a single input parameter and will show the item being calibrated and its circuit board position, a High and Low calibration point and the current value for that input.

The display cursor can be moved between the High and Low Calibration values using the [↑] (for up) and [↓] (for down) cursor keys and selecting by pressing the enter or return key. The new value is then entered using the numeric key pad and finally pressing the enter or return key to confirm.

At this stage in the calibration session the High and Low calibration point number changes have been recorded but are not being used by the Model 2000. The input parameter should now be physically altered until it corresponds to the High or Low calibration point and the display cursor set to point at which ever (High or Low) calibration point is being entered. The SET function key should be operated to set the physical input variable to the High or Low calibration point. The procedure can then be repeated for the other calibration point and can also be repeated as many times as required. It is recommended that the High and Low calibration points are as far apart in the span of the input as is practical and that should at least be at the extremes of the intended operating area. At any time in the calibration session the operator can revert back to either the DEFAULT or PREVIOUS calibration by operating the RESTORE function key and selecting the appropriate item.

The user can go on to calibrate as many Analogue input parameters as are required. Once all the changes are complete the user can leave the EDIT section by selecting the function key EXIT. Selecting the EXIT function will prompt with a EXIT menu as follows:-

3.0 INSTALLATION, INITIALISATION & CALIBRATION

Exit & Save	Exit the calibration mode, save the changes to memory and use the new values.
Exit & No Save	Exit the calibration mode, do not action any of the changes made.
Undo	Do not exit calibration mode and undo all previous changes in this session.

3.5.2 OUTPUT SIGNALS

3.5.2.1 DIGITAL OUTPUT SIGNALS

The Digital Output signals in the Model 2000 do not require any customer calibration to be carried out.

3.5.2.2 ANALOGUE OUTPUT SIGNALS

The Analogue Output signals are factory calibrated and should not require any customer adjustment, however, each Output has individual Gain (G) and Zero (Z) controls which can be adjusted to customer settings if required.

Controls VR2(Z) and VR1(G) adjust Output 1 pins A13 and B13
Controls VR4(Z) and VR3(G) adjust Output 2 pins A14 and B14
Controls VR6(Z) and VR5(G) adjust Output 3 pins A15 and B15
Controls VR8(Z) and VR7(G) adjust Output 4 pins A16 and B16

In order to assist calibration the Analogue Outputs can be set either to the minimum value (0mA or 4mA) or to the maximum value (20mA or 24mA) by using the following procedure.

When the CALIBRATION menu item is selected the user will be prompted to enter a four digit numeric password, to gain access to the calibration pages. It is possible to set-up a maximum of three different passwords and each of these passwords can be set to allow access or not to the calibration pages, these passwords are the same as used in the EDIT mode.

In its factory default condition the three available passwords are 1111, 2222 and 3333.

Once the password has been entered and accepted a calibration sub menu will appear as follows:-

Outputs	Selects calibration of any Analogue output.
Analogue	Selects calibration of any Analogue input.
Hart	Selects calibration of any Hart Loop input.
Exit	Returns operation to the Main Menu.

All Analogue outputs can be calibrated on the Output calibration page. The operator is prompted to:

Select the level of the analogue outputs

The F1 key will then select the Minimum range value either 0mA or 4mA, the value will depend upon the actual setting of the output board.

The F2 key will then select the Maximum range value either 20mA or 24mA, the value will depend upon the actual setting of the output board.

NOTE All Analogue Outputs in the M2000 will be set to either the Min or Max values at the same time when the unit is operated in this mode.

The user can go on to calibrate as many Analogue Output stages as are required. Once all the changes are complete the user can Exit the EDIT section by selecting the function key EXIT. Selecting the EXIT function will prompt with a EXIT menu as follows:-

3.0 INSTALLATION, INITIALISATION & CALIBRATION

Exit & Save	Exit the calibration mode, save the changes to memory and use the new values.
Exit & No Save	Exit the calibration mode, do not action any of the changes made.
Undo	Do not exit calibration mode and undo all previous changes in this session.

All Analogue Outputs will be set to the normal operating function after leaving the Calibrate mode.

4.0 MAINTENANCE

SECTION 4

4.0 MAINTENANCE

No routine servicing is required to ensure continuous operation, however should a system failure occur during operation, then the most likely cause of malfunction is that of a requirement not being fully or correctly implemented. If a fault or warning occurs, the cause should be determined in a logical and systematic manner and a guide is given below.

4.1 INITIAL CHECKS

1) Check that the power supply is of the correct type and value.
2) Check the fuse and that the power supply polarity is correct.
3) Ensure that all input and output connections to the plugs and sockets at the rear of the Model 2000 are satisfactory and the plugs are engaged firmly and in the correct sockets.
4) Ensure that all of the data entered via the keyboard or programmed via software is correct and that all of the calibration data has been entered and is correct.
5) Switch off the power to the Model 2000 and check that all of the circuit boards are fully engaged in their sockets and are positioned in the correct location.
6) Carry out a visual inspection of all wires and cables for obvious loose or broken connections.
7) Check that all external signal transmitters have the correct power supply voltages and that they are operational.

4.2 REPLACEMENT PARTS

The following replacement parts are available for maintenance purposes:-

Description	Part No.	BOM No.
Microprocessor Board	2000-3-034	2034
Microprocessor Board (Large RAM)	2000-3-024	2024
Output Board	2000-3-033	2033
Input Board	2000-3-037	2037
PRT Input Board	2000-3-030	2030
Input 2 Board	2000-3-080	2080
DC/DC Converter Board	2000-3-038	2038
Display Board	2000-3-031	2031
Communications Board	2000-3-032	2032
Network 2 Board	2000-3-88	2088
Programming Cable (Com Port Type)	2000-3-070	2070
Programming Cable (USB Type)	2000-3-075	2075
USB A-A Cable 2m long	CAB152-778	
MPU Board Replacement Battery	BATBR2330	

When replacement boards are fitted it may be necessary to change the customer link settings. The following tables show the user link functions on the circuit boards where changes may require to be made. All circuit boards not listed do not have user changeable links.

4.0 MAINTENANCE

4.3 INPUT BOARD LINK SETTINGS

Link No.	Function	Factory setting	Notes
1	HF Input 1 Resistor bypass	OMIT	
2	HF Input 1 0V 24 Connection	OMIT	
3	HF Input 2 Resistor bypass	OMIT	
4	HF Input 2 0V 24 Connection	OMIT	
5	Status Input 1 Resistor bypass	OMIT	
6	Status Input 1 0V 24 Connection	OMIT	
7	Status Input 2 Resistor bypass	OMIT	
8	Status Input 2 0V 24 Connection	OMIT	
9	Status Input 3 Resistor bypass	OMIT	
10	Status Input 3 0V 24 Connection	OMIT	
11	0VD to 0VA	FIT	No customer option
12	HART Loop 1 0V	FIT	No customer option
13	HART Loop 2 0V	FIT	No customer option
14	+12V Bypass link	FIT	No customer option
15	-12V Bypass link	FIT	No customer option
16	HF Input 1 de-bounce ON	OMIT	
17	HF Input 1 de-bounce OFF	FIT	
18	HF Input 2 de-bounce OFF	FIT	
19	HF Input 2 de-bounce ON	OMIT	

Note on early issues of the above board links 14 to 19 may not be present.
See figure 7 for the location of the links.

4.0 MAINTENANCE

4.4 INPUT 2 BOARD LINK SETTINGS

Link No.	Function	Factory setting	Notes
1	HF Input 1 Resistor bypass	OMIT	
2	HF Input 1 0V 24 Connection	OMIT	
3	HF Input 2 Resistor bypass	OMIT	
4	HF Input 2 0V 24 Connection	OMIT	
5	Status Input 1 Resistor bypass	OMIT	
6	Status Input 1 0V 24 Connection	OMIT	
7	Status Input 2 Resistor bypass	OMIT	
8	Status Input 2 0V 24 Connection	OMIT	
9	Status Input 3 Resistor bypass	OMIT	
10	Status Input 3 0V 24 Connection	OMIT	
11	0VD to 0VA	FIT	No customer option
12	HART Loop 1 0V	FIT	No customer option
13	HART Loop 2 0V	FIT	No customer option
14	+12V Bypass link	FIT	No customer option
15	-12V Bypass link	FIT	No customer option
16	HF Input 1 de-bounce ON	OMIT	
17	HF Input 1 de-bounce OFF	FIT	
18	HF Input 2 de-bounce OFF	FIT	
19	HF Input 2 de-bounce ON	OMIT	

See figure 27 for the location of the links.

4.5 OUTPUT BOARD LINK SETTINGS

Output No.	Link No.	0-24mA	0-20mA	4-20mA	Factory setting
O/P1	1	OMIT	FIT A	FIT B	B
O/P2	2	OMIT	FIT A	FIT B	B
O/P3	3	OMIT	FIT A	FIT B	B
O/P4	4	OMIT	FIT A	FIT B	B

See figure 13 for the location of the links.

4.6 DISPLAY BOARD LINK SETTINGS

Link No.	Function	Factory setting	Notes
1	IrDa Communication Port	FIT	No customer option
2	RS232 Communication Port	OMIT	No customer option
3	+5V LCD Power	FIT	No customer option
4	0V LCD Power	FIT	No customer option

See figure 9 or Figure 24 for the location of the links.

4.0 MAINTENANCE

4.7 PRT INPUT BOARD LINK SETTINGS

Link No.	Function	Factory setting	Notes
1	HF Input 1 Resistor bypass	OMIT	
2	HF Input 1 0V 24 Connection	OMIT	
3	HF Input 2 Resistor bypass	OMIT	
4	HF Input 2 0V 24 Connection	OMIT	
5	Status Input 1 Resistor bypass	OMIT	
6	Status Input 1 0V 24 Connection	OMIT	
7	Status Input 2 Resistor bypass	OMIT	
8	Status Input 2 0V 24 Connection	OMIT	
9	Status Input 3 Resistor bypass	OMIT	
10	Status Input 3 0V 24 Connection	OMIT	
11	0VD to 0VA	FIT	No customer option
12	HART Loop 1 0V	FIT	No customer option
13	HART Loop 2 0V	FIT	No customer option
14	+12V Bypass link	FIT	No customer option
15	-12V Bypass link	FIT	No customer option
16	HF Input 1 de-bounce ON	OMIT	
17	HF Input 1 de-bounce OFF	FIT	
18	HF Input 2 de-bounce OFF	FIT	
19	HF Input 2 de-bounce ON	OMIT	

See figure 15 for the location of the links.

4.8 COMMS BOARD LINK SETTINGS

Issue 4 type Communication Board Assy 2000-3-032 are fitted with Links 1 – 4 as described below

Link No.	Function	Factory setting	Notes
1	RS485 Terminating Resistor Port 3 On/Off	OFF	LK 1 and 2 should be
2	RS485 Terminating Resistor Port 3 On/Off	OFF	both ON or OFF
3	RS485 Terminating Resistor Port 4 On/Off	OFF	LK 3 and 4 should be
4	RS485 Terminating Resistor Port 4 On/Off	OFF	both ON or OFF

See figure 11A for the location of the links.

APPENDIX 1 ALARM, WARNING & FAULT CODES

APPENDIX 1

ALARM, WARNING AND FAULT CODES

The alarm, warning and fault codes shown on the display when the alarm pages are selected contain a alarm function code as listed below together with the time and date that the alarm was set and reset (if that has occurred).

In all the following items N will indicate the Stream number 1, 2 or 3.

PARAMETER SYMBOLS FOR NON-ACCOUNTABLE ALARMS

qN low	The uncorrected flow rate is below the value of Lo qN.
prN High	The pressure used is above the values of PressureN High.
prN Low	The pressure used is below the values of PressureN Low.
teN High	The temperature used is above the values of TemperatureN High.
teN Low	The temperature used is below the values of TemperatureN Low.

For Station Pressure and Temperature only.

S.pr1 high	The Station pressure 1 is above the values of S.pr1 high.
S.pr1 low	The Station pressure 1 is below the values of S.pr1 low.
S.te1 high	The Station temperature 1 is above the values of S.te1 high.
S.te1 low	The Station temperature 1 is below the values of S.te1 low.
S.pr2 high	The Station pressure 2 is above the values of S.pr2 high.
S.pr2 low	The Station pressure 2 is below the values of S.pr2 low.
S.te2 high	The Station temperature 2 is above the values of S.te2 high.
S.te2 low	The Station temperature 2 is below the values of S.te2 low.

For Turbine meters only.

turbN lf	An lf turbine meter alarm (blade failure) has occurred.

For US meters only.

usN eff.1%	Meter path 1 efficiency is below pre-set % limit.
usN eff.2%	Meter path 2 efficiency is below pre-set % limit.
usN eff.3%	Meter path 3 efficiency is below pre-set % limit.
usN eff.4%	Meter path 4 efficiency is below pre-set % limit.
usN eff.5%	Meter path 5 efficiency is below pre-set % limit.
usN Units	Meter set to wrong Units (ABB Totalsonic Only)

For Non Instromet US Meter types only

usN Status	Meter returned invalid status
usN Status 1	Meter returned invalid status path 1
usN Status 2	Meter returned invalid status path 2
usN Status 3	Meter returned invalid status path 3
usN Status 4	Meter returned invalid status path 4

For Orifice plate operation only.

dph1.N hi	High range dp sensor 1 is above the values of dp hi 1 N hi.
dph1.N lo	High range dp sensor 1 is below the values of dp hi 1 N lo.
dpl1.N hi	Low range dp sensor 1 is above the values of dp lo 1 N hi.
dpl1.N lo	Low range dp sensor 1 is below the values of dp lo 1 N lo.

For Smart Index Meters only.

SI reset1	Code 0x31 reset and no valid code in EEPROM
SI reset2	Code 0x32 reset and index values are equal
SI 2ram	Code 0x33 2 of 3 Ram index values are equal.
SI 3ram	Code 0x34 all of 3 index values are equal
SI wire	Code 0x35 Failure of Wiegand pulse wire
SI Namur	Code 0x36 items missing in Namur protocol
SI ram	Code 0x37 Ram check failure
SI eeprom	Code 0x38 EPROM check failure
SI other	Any other received status code

For Coriolis Meters only.

CMN dev	Deviation between Primary and secondary flow source

For Grab Sampler only.

GSN expire	Grab Sampler Production period expired
GSN limit	Grab Sampler Can level greater than alarm limit

APPENDIX 1 ALARM, WARNING & FAULT CODES

GSN dev	Deviation between the actual and the estimated/calculated fill level.
GSN rate	Grab Sampler Sample Rate Alarm.

Gas data and gas chromatograph alarms only.

rd.N lo/hi	Relative density below Lo or above Hi alarm levels.
SG.N lo/hi	Specific Gravity (Liquids) below Lo or above Hi alarm levels.
hs.N lo/hi	Superior Heating Value below Lo or above Hi alarm levels.
hi.N lo/hi	Inferior Heating Value below Lo or above Hi alarm levels.
C1.N lo/hi	Methane below Lo or above Hi alarm levels.
N2.N lo/hi	Nitrogen below Lo or above Hi alarm levels.
CO2.N lo/hi	Carbon Dioxide below Lo or above Hi alarm levels.
C2.N lo/hi	Ethane below Lo or above Hi alarm levels.
C3.N lo/hi	Propane below Lo or above Hi alarm levels.
H2O.N lo/hi	Water Vapour below Lo or above Hi alarm levels.
H2S.N lo/hi	Hydrogen Sulphide below Lo or above Hi alarm levels.
H2.N lo/hi	Hydrogen below Lo or above Hi alarm levels.
CO.N lo/hi	Carbon Monoxide below Lo or above Hi alarm levels.
O2.N lo/hi	Oxygen below Lo or above Hi alarm levels.
i-C4.N lo/hi	i-Butane below Lo or above Hi alarm levels.
n-C4.N lo/hi	n-Butane below Lo or above Hi alarm levels.
i-C5.N lo/hi	i-Pentane below Lo or above Hi alarm levels.
n-C5.N lo/hi	n-Pentane below Lo or above Hi alarm levels.
ne-C5.N lo/hi	neo-Pentane below Lo or above Hi alarm levels.
n-C6.N lo/hi	Hexane below Lo or above Hi alarm levels.
n-C7.N lo/hi	Heptane below Lo or above Hi alarm levels.
n-C8.N lo/hi	Octane below Lo or above Hi alarm levels.
n-C9.N lo/hi	Nonane below Lo or above Hi alarm levels.
n-C10.N lo/hi	Decane below Lo or above Hi alarm levels.
He.N lo/hi	Helium below Lo or above Hi alarm levels.
Ar.N lo/hi	Argon below Lo or above Hi alarm levels.
Chrm str	Gas Chromatograph stream error.
Chrm cal	Gas Chromatograph is in calibrate mode.
Chrm state	Gas Chromatograph is in non analysis state.

Gas density measurement alarms only.

dens.N lo/hi	Density below Lo or above Hi alarm levels.
dens dev	Density values in deviation
rd dev	Relative Density values in deviation.

For Oil Lubrication Status Input only.

oil level N	Oil Level Status input alarm

PARAMETER SYMBOLS FOR ACCOUNTABLE ALARMS

pr1.N max	Pressure sensor 1 is above the values of pressureN max.
pr1.N min	Pressure of sensor 1 is below the values of pressureN min.
pr1.N val	There is no value for pressure sensor 1.
pr1.N hart	A communications failure has occurred between the Model 2000 and pressure sensor 1.
pr1.N hsts	Pressure sensor 1 is in a sensor generated alarm condition.
pr1.N unit	The selected pressure units do not match the units indicated by pressure sensor 1.
pr1.N dev	Pressure sensor 1 is outside the deviation limit.
pr1.N adev	Pressure sensor 1 is outside the average deviation limit.
te1.N max	Temperature sensor 1 is above the values of temp.N max.
te1.N min	Temperature sensor 1 is below the values of temp N min.
te1.N val	There is no value for temperature sensor 1.
te1.N hart	A communications failure has occurred between the Model 2000 and temperature sensor 1.
te1.N hsts T	Temperature sensor1 is in a sensor generated alarm condition.
te1.N unit	The selected temperature units do not match the units indicated by temperature sensor 1.

APPENDIX 1 ALARM, WARNING & FAULT CODES

te1.N dev	Temperature sensor 1 is outside the deviation limit.
te1.N adev	Temperature sensor 1 is outside the average deviation limit.
prserIN max	The serial check pressure is above the value of pressure.N max.
prserIN min	The serial check pressure is below the value of pressure.N min.
teserIN max	The serial check temp. is above the value of temp.N max.
teserIN max	The serial check temp. is above the value of temp.N min.
qN high	The uncorrected flow rate is above the value of Hi qN. for more than 1 minute.
znN high	Base compressibility outside tolerance znN high.
znN low	Base compressibility outside tolerance znN low.
Calibrate	Unit is in the calibrate mode.
zN calc	Compressibility cannot be calculated.
znN calc	Base Compressibility cannot be calculated.
Modbus err	Modbus Communication port timeout alarm.

For Station Pressure and Temperature only.

S.pr1 max	Station Pressure 1 is above the values of S.pr1 max.
S.pr1 min	Station Pressure 1 is below the values of S.pr1 min.
S.pr1 val	There is no value for Station pressure 1.
S.pr1 hart	A comms failure has occurred between the Model 2000 and Station pressure sensor 1.
S.pr1 hsts	Station Pressure sensor 1 has a sensor generated alarm condition.
S.pr1 unit	The selected Station pressure units do not match the units indicated by Station pressure sensor 1.
S.te1 max	Station Temperature sensor 1 is above the values of S.te1 max.
S.te1 min	Station Temperature sensor 1 is below the values of S.te1 min.
S.te1 val T	here is no value for Station temperature 1.
S.te1 hart	A comms failure has occurred between the Model 2000 and Station temperature sensor 1.
S.te1 hsts	Station Temperature sensor 1 has a sensor generated alarm condition.
S.te1 unit	The selected Station temperature units do not match the units indicated by Station temperature sensor 1.
S.pr2 max	Station Pressure 2 is above the values of S.pr2 max.
S.pr2 min	Station Pressure 2 is below the values of S.pr2 min.
S.pr2 val	There is no value for Station pressure 2.
S.pr2 hart	A comms failure has occurred between the Model 2000 and Station pressure sensor 2.
S.pr2 hsts	Station Pressure sensor 2 has a sensor generated alarm condition.
S.pr2 unit	The selected Station pressure units do not match the units indicated by Station pressure sensor 2.
S.te2 max	Station Temperature sensor 2 is above the values of S.te2 max.
S.te2 min	Station Temperature sensor 2 is below the values of S.te2 min.
S.te2 val	There is no value for Station temperature 2.
S.te2 hart	A comms failure has occurred between the Model 2000 and Station temperature sensor 2.
S.te2 hsts	Station Temperature sensor 2 has a sensor generated alarm condition.
S.te2 unit	The selected Station temperature units do not match the units indicated by Station temperature sensor 2.

For Turbine meters only.

turbN hf	An hf turbine meter alarm (blade failure) has occurred.

For US meters only.

usN paths	Wrong number of acoustic paths specified.
usN secur.	Meter security alarm bit set.
usN level1	Reduced accuracy alarm.
usN level2	Reduced accuracy alarm.
usN number	Invalid number received alarm.
usN comms	No valid communications from the meter for last 5 seconds.
usN mode	US meter is in non measurement mode (ABB Totalsonic only)

For Orifice plate operation only.

dph1.N max	High range dp sensor 1 is above the values of dp hi 1 N max.
dph1.N min	High range dp sensor 1 is below the values of dp hi 1 N min.
dph1.N val.	There is no value for high range dp sensor 1.
dph1.N hrt	A comms failure has occurred between the Model 2000 and high range dp sensor.

APPENDIX 1 ALARM, WARNING & FAULT CODES

dph1.N hst	high range dp sensor 1 is in a sensor generated alarm condition.
dph1.N unt	The selected dp units do not match the units indicated by high range dp sensor 1.
dph1.N dev	High range dp sensor 1 is outside the deviation limit.
dph1.N adev	High range dp sensor 1 is outside the average deviation limit.
dpl1.N max	Low range dp sensor 1 is above the values of dp lo 1 N max.
dpl1.N min	Low range dp sensor 1 is below the values of dp lo 1 N min.
dpl1.N val.	There is no value for low range dp sensor 1.
dpl1.N hrt	A comms failure has occurred between the Model 2000 and low range dp sensor.
dpl1.N hst	Low range dp sensor 1 is in a sensor generated alarm condition.
dpl1.N unt	The selected dp units do not match the units indicated by low range dp sensor 1.
dpl1.N dev	Low range dp sensor 1 is outside the deviation limit.
dpl1.N adev	Low range dp sensor 1 is outside the average deviation limit.
dphselN max	The serial check high range dp is above the value of dp hi N max.
dphselN min	The serial check pressure is below the value of dp hi N min.
dplselN max	The serial check temp. is above the value of dp loN max.
dplselN max	The serial check temp. is above the value of dp lo N min.

NOTE In all cases above relating to pressure, temperature and differential pressure alarms the numeric character could be 1, 2 or 3 depending upon the number of selected multiple transmitters.

For Smart index meters only.

SI comms	No communication from Smart Index.
SI packet	Incorrect data packet from Smart Index.

For Coriolis Meters only.

dm val max	Density value from meter is above density Maximum alarm level.
dm val min	Density value from meter is below density Minimum alarm level.
CMN port	Communication port used for Coriolis meter set up problem.
CMN comms	Comms. failure or problem between FC2000 and Coriolis meter.
CMN units	Units read from Coriolis meter different from those set in FC2000.
CMN status	Coriolis Meter Status alarm.

For Grab Sampler only.

GSN full	Grab Sampler Can Full Alarm.
GSN reset	An attempt has been made to Reset the Grab Sampler whilst operating.
GSN speed	Grab Sampler Over speed alarm. (Number of grabs per mass unit (at current flowrate) > max sampler speed)

Gas data and gas chromatograph alarms only.

rd.N min/max	Relative density below min or above max alarm levels.
SG.N min/max	Specific Gravity (Liquids) below min or above max alarm levels.
hs.N min/max	Superior Heating Value below min or above max alarm levels.
hi.N min/max	Inferior Heating Value below min or above max alarm levels.
C1.N min/max	Methane below min or above max alarm levels.
N2.N min/max	Nitrogen below min or above max alarm levels.
CO2.N min/max	Carbon Dioxide below min or above max alarm levels.
C2.N min/max	Ethane below min or above max alarm levels.
C3.N min/max	Propane below min or above max alarm levels.
H2O.N min/max	Water Vapour below min or above max alarm levels.
H2S.N min/max	Hydrogen Sulphide below min or above max alarm levels.
H2.N min/max	Hydrogen below min or above max alarm levels.
CO.N min/max	Carbon Monoxide below min or above max alarm levels.
O2.N min/max	Oxygen below min or above max alarm levels.
i-C4.N min/max	i-Butane below min or above max alarm levels.
n-C4.N min/max	n-Butane below min or above max alarm levels.
i-C5.N min/max	i-Pentane below min or above max alarm levels.
n-C5.N min/max	n-Pentane below min or above max alarm levels.
ne-C5.N min/max	neo-Pentane below min or above max alarm levels.
n-C6.N min/max	Hexane below min or above max alarm levels.
n-C7.N min/max	Heptane below min or above max alarm levels.
n-C8.N min/max	Octane below min or above max alarm levels.

APPENDIX 1 ALARM, WARNING & FAULT CODES

n-C9.N min/max	Nonane below min or above max alarm levels.
n-C10.N min/max	Decane below min or above max alarm levels.
He.N min/max	Helium below min or above max alarm levels.
Ar.N min/max	Argon below min or above max alarm levels.
Chrm comp	Gas Chromatograph component alarm.
Chrm comms	Gas Chromatograph communication error.
Chrm str N	Gas Chromatograph Stream specific Alarm.
Chrm alarm	Gas Chromatograph status error.

Gas density measurement alarms only.

densN-f lo/hi	Density frequency input below 500Hz or above 5000Hz.
rdN-f low/high	Rel. dens. frequency input below 500Hz or above 5000Hz.

For Station Controllers only.

SC read N	A Station Controller communication Read from a Flow computer has failed.
SC write N	A Station Controller communication Write to a Flow computer has failed.
Totals Err	Station Controller is unable to calculate Station totals.
Vb Compare	Station Controller comparison between Vb stream flows alarm.
Vn Compare	Station Controller comparison between Vn stream flows alarm.

APPENDIX 1 ALARM, WARNING & FAULT CODES

TEMPERATURE ALARM

tempN alrm Temperature below t-alarm and qb above Lo.q for more than a preset time interval.

FAULT CODES

In all the following items X will indicate the user board slot number 1, 2, 3, 4 or 5.

Fault ipX	Faulty or missing Input board in user position X.
Fault opX	Faulty or missing Output board in user position X.
Fault comX	Faulty or missing Communication board in user position X.
Fault netX	Faulty or missing Network board in user position X.
Fault brdX	Wrong board type in user position X.
Fault data	No or incomplete data for operation.
Fault rtc	Real Time Clock fault or failure.

WARNING CODES

In all the following items :-

X will indicate the user board slot number 1, 2, 3, 4 or 5.

Y will indicate 1 for the upper communication port and 2 for the lower.

Warn ipX	Missing Input board in user position X.
Warn opX	Missing Output board in user position X.
Warn comX	Missing Comms. board in user position X.
Warn brdX	Wrong board type in user position X.
Err Maint.	Unit is currently in the maintenance mode.
proving	Unit is currently in the proving mode.
CalDefault	Unit is currently using Default Calibration data.
Warn cts X.Y	Serial Port Handshaking line CTS pending timeout.
Div zero	A divide by zero has occurred, followed by number of times and the absolute address of the last occurrence.
op1 brdX	Pulse Output 1 on Output Board in position X is Overrange.
op2 brdX	Pulse Output 2 on Output Board in position X is Overrange.
op3 brdX	Pulse Output 3 on Output Board in position X is Overrange.
op4 brdX	Pulse Output 4 on Output Board in position X is Overrange.
op5 brdX	Pulse Output 5 on Output Board in position X is Overrange.
op6 brdX	Pulse Output 6 on Output Board in position X is Overrange.
op7 brdX	Pulse Output 7 on Output Board in position X is Overrange.
op8 brdX	Pulse Output 8 on Output Board in position X is Overrange.
op9 brdX	Pulse Output 9 on Output Board in position X is Overrange.
op10 brdX	Pulse Output 10 on Output Board in position X is Overrange.
op11 brdX	Pulse Output 11 on Output Board in position X is Overrange.
op12 brdX	Pulse Output 12 on Output Board in position X is Overrange.

APPENDIX 2 AUDIT LOG EVENT CODES

APPENDIX 2

EVENT CODES

The following is a list of Events that can be recorded by the Model 2000 in the event log.

Event Status Code	EVENT TYPE
0	No Event
1	Power ON
2	Reset
3	New .S19 file downloaded
4	Event log cleared
5	Calibration Data changed
6	Front Panel Settings changed
7	New Time/Date Set using EDIT mode
8	New Time/Date Set using M2000 Windows Software
9	New Time/Date Set using Modbus communication
10	Preset Data changed using EDIT mode
11	Preset Data changed using M2000 Windows Software
12	Modbus Data written to M2000
13	Maintenance Mode switched ON
14	Maintenance Mode switched OFF
15	Proving Mode switched ON
16	Proving Mode switched OFF
17	P/T Calibrate Mode switched ON
18	P/T Calibrate Mode switched OFF
19	Security Switch No 1 changed from OFF to ON
29	Security Switch No 1 changed from ON to OFF
21	Security Switch No 2 changed from OFF to ON
22	Security Switch No 2 changed from ON to OFF
23	Security Switch No 3 changed from OFF to ON
24	Security Switch No 3 changed from ON to OFF
25	Security Switch No 4 changed from OFF to ON
26	Security Switch No 4 changed from ON to OFF
27	Totals Hold Button operated
28	All Alarm History cleared
29	Fault History cleared
30	Accountable Alarm History cleared
31	Non Accountable Alarm History cleared
32	Warnings History cleared
33	Display pages have changed
34	Information pages have changed
35	Input Board settings have changed
36	Output Board settings have changed by EDIT mode
37	Output Board settings have changed by M2000 Windows software
38	Modbus settings have changed
39	Print Job settings have changed
40	Data to Print settings have changed
41	Port Settings have changed
42	Unit Security settings have changed
43	Ethernet settings have changed
44	Counter Prefix table has changed
45	Preset ids in Event log have changed

APPENDIX 2 AUDIT LOG EVENT CODES

Event Status Code	EVENT TYPE	
46	Lubrication Start 1	
47	Lubrication Start 2	
48	Lubrication Start 3	
49	Lubrication Start 4	
50	Lubrication Start 5	
51	Lubrication Error 1	
52	Lubrication Error 2	
53	Lubrication Error 3	
54	Lubrication Error 4	
55	Lubrication Error 5	
56	Time Set by digital Input	
57	New meter K factor written	Liquid M2000 only
58	Stream 1 switched Online	
59	Stream 1 switched Offline	
60	Stream 2 switched Online	
61	Stream 2 switched Offline	
62	Stream 3 switched Online	
63	Stream 3 switched Offline	
64	Stream 4 switched Online	
65	Stream 4 switched Offline	
66	Stream 5 switched Online	
67	Stream 5 switched Offline	
68 to 74	Reserved for Future Use	
75 to 94	Preset id Numbers 1 to 20 in Event log have changed	

APPENDIX 3 GAS CHROMATOGRAPHS SUPPORTED

APPENDIX 3

GAS CHROMATOGRAPHS SUPPORTED

The following is a list of Gas Chromatographs that are supported for connection to the Model 2000 and the Modbus Addresses that will be read.

See Tables 1 and 2	Instromet ENCAL 2000
	Daniels Model 2251
	Daniels Model 2551
	Daniels Model 2350
	Instromet USA Model
	Instromet Encal (India Software)
	ABB Model 8000/8100
See Table 3	Yamatake Model HGC303
See Table 4	Siemens Optichrome
See Table 5	Rosemount GCX
See Table 6	Instromet Station Controller Type 793-7SC
See Table 7	Instromet M2000 in GC Emulation Mode.
	Instromet Ensonic
See Table 8	ABB Model 3100

For OSC-01-E see Gas Unie Document for Protocol information.

The Instromet and Daniels gas chromatographs will have the same Modbus addresses read by the Model 2000, in the case of the ENCAL addresses 3001 to 3016 and 7001 to 7016 which contain the component codes and values are fixed as shown. In the other Daniels machines they are not fixed and can appear in different orders.

APPENDIX 3 GAS CHROMATOGRAPHS SUPPORTED

Table 1 Status information Instromet/Daniels/ABB models

Addr.	Function	Code	Number Format
3034	GC Stream Number	1, 2 or 3	unsigned 16 bit integer
3059	Analysis/Calibration	1=Analysis 0=Calibration	unsigned 16 bit integer
3062	Process Gas Chromatograph State (Not Read in ABB 8000/8100 & Daniels 2251)	0=Idle 1=Analysing 2=Calibrating	unsigned 16 bit integer
3046	GC Status register 1 (See GC manual for details)	0 = OK	unsigned 16 bit integer
3047	GC status register 2 (See GC manual for details)	0 = OK	unsigned 16 bit integer
3070	GC Status register 1 ABB 8000/8100 Only (See GC manual for details)	0 = OK	unsigned 16 bit integer
3071	GC Status register 2 ABB 8000/8100 Only (See GC manual for details)	0 = OK	unsigned 16 bit integer

Unit will continue to read the above registers until the following conditions are correct

3034 = Stream Number
3059 = 1 i.e. Analysis
3062 = 1 i.e. Analysing
3046 = 0 i.e. OK
3047 = 0 i.e. OK

When these conditions are met it will continue to read addresses 3001 to 3016 & 7001 to 70016 & appropriate registers in the range 7033 to 7089

NOTE Instromet ENCAL (Indian Software) does not read address 3034 = Stream Number a value of stream 1 is assumed.

Table 2 Gas Data Instromet/Daniels/ABB models
Example codes 3001 to 3016 can appear in any order

3001	Component code for C6+	108	unsigned 16 bit integer
3002	Component code for N2	114	unsigned 16 bit integer
3003	Component code for Methane	100	unsigned 16 bit integer
3004	Component code for CO2	117	unsigned 16 bit integer
3005	Component code for Ethane	101	unsigned 16 bit integer
3006	Component code for Propane	102	unsigned 16 bit integer
3007	Component code for i-Butane	103	unsigned 16 bit integer
3008	Component code for n-Butane	104	unsigned 16 bit integer
3009	Component code for neo-pentane	107	unsigned 16 bit integer
3010	Component code for i-pentane	105	unsigned 16 bit integer
3011	Component code for n-pentane	106	unsigned 16 bit integer
3012	Component code for H2	112	unsigned 16 bit integer
3013	Component code for Helium	113	unsigned 16 bit integer
3014	Component code for Oxygen	116	unsigned 16 bit integer
3015	Component code for CO	115	unsigned 16 bit integer
3016	Component code for H2O	144	unsigned 16 bit integer

APPENDIX 3 GAS CHROMATOGRAPHS SUPPORTED

Table 2 cont. Gas Analysis results Instromet/Daniels/ABB models
Example codes 7001 to 7016 can appear in any order

Address	Function	Number Format
7001	Mol % C6+	IEEE 32 bit Float
7002	Mol % N2	IEEE 32 bit Float
7003	Mol % Methane	IEEE 32 bit Float
7004	Mol % CO2	IEEE 32 bit Float
7005	Mol % Ethane	IEEE 32 bit Float
7006	Mol % Propane	IEEE 32 bit Float
7007	Mol % i-Butane	IEEE 32 bit Float
7008	Mol % n-Butane	IEEE 32 bit Float
7009	Mol % neo-Pentane	IEEE 32 bit Float
7010	Mol % i-Pentane	IEEE 32 bit Float
7011	Mol % n-Pentane	IEEE 32 bit Float
7012	Mol % H2	IEEE 32 bit Float
7013	Mol % Helium	IEEE 32 bit Float
7014	Mol % Oxygen	IEEE 32 bit Float
7015	Mol % CO	IEEE 32 bit Float
7016	Mol % Water Vapour	IEEE 32 bit Float
7033	Superior Heating Value (Dry)	IEEE 32 bit Float
7034	Superior Heating Value (Sat)	IEEE 32 bit Float
7035	Relative Density	IEEE 32 bit Float
7037	Wobbe index (Superior)	IEEE 32 bit Float
7039	Wobbe index (Inferior) USA ENCAL Only	IEEE 32 bit Float
7087	Inferior Heating Value (Dry) Not Read by USA ENCAL	IEEE 32 bit Float
7088	Wobbe index (Inferior) ABB 8000/8100 Only	IEEE 32 bit Float
7089	Wobbe index (Inferior) Not Read by USA ENCAL	IEEE 32 bit Float

APPENDIX 3 GAS CHROMATOGRAPHS SUPPORTED

Table 3 Status information and Gas Analysis results Yamatake HGC303

Address	Function		Number Format
3058	New data available flag	1 = Ready 0 = Copy Data	unsigned 16 bit integer
3059	Analysis/Calibration	1 = Analysis 0 = Calibration	unsigned 16 bit integer
3047	GC status register (See GC manual for details)	0 = OK	unsigned 16 bit integer

Unit will continue to read the above 3 registers until the following conditions are correct

3058 = 1 i.e. Ready
3059 = 1 i.e. Analysis
3047 = 0 i.e. OK

When these conditions are met it will continue to read addresses 7001 to 7020

Address	Function	Number Format
7001	Mol % C6+	IEEE 32 bit Float
7002	Mol % Propane	IEEE 32 bit Float
7003	Mol % i-Butane	IEEE 32 bit Float
7004	Mol % n-Butane	IEEE 32 bit Float
7005	Mol % neo-Pentane	IEEE 32 bit Float
7006	Mol % i-Pentane	IEEE 32 bit Float
7007	Mol % n-Pentane	IEEE 32 bit Float
7008	Mol % N2	IEEE 32 bit Float
7009	Mol % Methane	IEEE 32 bit Float
7010	Mol % CO2	IEEE 32 bit Float
7011	Mol % Ethane	IEEE 32 bit Float
7012	Superior Heating Value	IEEE 32 bit Float
7013	Not Used	
7014	Wobbe index (Superior)	IEEE 32 bit Float
7015	Not Used	
7016	Not Used	
7017	Not Used	
7018	Not Used	
7019	Not Used	
7020	Relative Density	IEEE 32 bit Float

APPENDIX 3 GAS CHROMATOGRAPHS SUPPORTED

Table 4 Component codes and Status information Siemens Optichrome

Gas Component	Default Address	Number Format
Status	30001	unsigned 16 bit integer

Unit will continue to read the above register until the following conditions are correct
30001 is greater than the alarm limit value
When these conditions are met it will continue to read addresses 41701 to 43101

Gas Component	Default Address	Number Format
Nitrogen N2	41701	unsigned 16 bit integer
Carbon Dioxide CO2	41901	unsigned 16 bit integer
Rel dens	42701	unsigned 16 bit integer
Superior Heating Value Hs	42601	unsigned 16 bit integer
Inferior Heating Value Hi	42801	unsigned 16 bit integer
Methane C1	41801	unsigned 16 bit integer
Ethane C2	42101	unsigned 16 bit integer
Propane C3	41201	unsigned 16 bit integer
i-Butane i-C4	41301	unsigned 16 bit integer
n-Butane n-C4	41401	unsigned 16 bit integer
i-Pentane i-C5	41501	unsigned 16 bit integer
n-Pentane n-C5	41601	unsigned 16 bit integer
C6+	41101	unsigned 16 bit integer
Wobbe (superior)	43101	unsigned 16 bit integer

The Siemens Optichrome interface supports the Following Modbus commands only

1) Read requests of Data Registers
[T1-T2-T3-T4]KK03ssssnnnn<CRC>[T1-T2-T3-T4]

2) Read requests of Status Registers
[T1-T2-T3-T4]KK04ssssnnnn<CRC>[T1-T2-T3-T4]

3) Force Single Coil Instruction (Sent Automatically every 10 seconds)
[T1-T2-T3-T4]KK05<FF00><CRC>[T1-T2-T3-T4]

The Expected responses to the above packets from the GC are as follows:-

1) Valid Data Read Requests:
[T1-T2-T3-T4]KK03bb<DATA><CRC>[T1-T2-T3-T4]

2) Valid Status Read Requests:
[T1-T2-T3-T4]KK04bb<DATA><CRC>[T1-T2-T3-T4]

3) Force Single Coil Instruction
[T1-T2-T3-T4]KK05<FF00><CRC>[T1-T2-T3-T4]

Where:

a) [T1-T2-T3-T4] is at least 3.5 character times of silent interval.
b) KK is the identification number.
c) 03 hex is the Modbus code "Read multiple holding registers".
d) 04 hex is the Modbus code "Read Input register".
e) 05 hex is the Modbus code "Force Single Coil".
f) ssss is the start address in the range 0000 to FFFF (0 to 63535 decimal).
g) nnnn number of registers in the range 0001 to 00FF (1 to 255 decimal).
h) bb is the number of bytes to be transferred.
i) <FF00> is the Single Coil address.
j) <DATA> data nnnn items.
l) <CRC> CRC Checksum.

APPENDIX 3 GAS CHROMATOGRAPHS SUPPORTED

Table 5 Component codes and Status information Rosemount GCX

Gas Component	Default Address	Number Format
Status	10001	0 = OK 1 = Reset
Status	10002	0 = Run 1 = Stopped
Status	10003 to 10008	Ignored
Status	10009 to 100012	Ignored
Status	10013	1 = Sample flowing
Status	10014	1 = Flame Lit
Status	10015 to 10016	Ignored

Unit will continue to read the above status bit registers until the following conditions are correct
10001 = 0 i.e. OK
10002 = 0 i.e. Run
10013 = 1 i.e. Sample flowing
10014 = 1 i.e. Flame Lit
When these conditions are met it will continue to read addresses 30001 to 30020

Gas Component	Default Address	Number Format
Nitrogen N2	30001	unsigned 16 bit integer
Carbon Dioxide CO2	30003	unsigned 16 bit integer
Rel dens	30019	unsigned 16 bit integer
Superior Heating Value Hs	30015	unsigned 16 bit integer
Inferior Heating Value Hi	30016	unsigned 16 bit integer
Methane C1	30002	unsigned 16 bit integer
Ethane C2	30004	unsigned 16 bit integer
Propane C3	30005	unsigned 16 bit integer
i-Butane i-C4	30006	unsigned 16 bit integer
n-Butane n-C4	30007	unsigned 16 bit integer
i-Pentane i-C5	30009	unsigned 16 bit integer
n-Pentane n-C5	30010	unsigned 16 bit integer
C6+	30011	unsigned 16 bit integer
Wobbe (superior)	30020	unsigned 16 bit integer

The Rosemount GCX interface supports the Following Modbus commands only

1) Read requests of Data Registers
   [T1-T2-T3-T4]KK04ssssnnnn<CRC>[T1-T2-T3-T4]

2) Read requests of Status Registers
   [T1-T2-T3-T4]KK02ssssnnnn<CRC>[T1-T2-T3-T4]

The Expected responses to the above packets from the GC are as follows:-

1) Valid Data Read Requests:
   [T1-T2-T3-T4]KK04bb<DATA><CRC>[T1-T2-T3-T4]

2) Valid Status Read Requests:
   [T1-T2-T3-T4]KK02bb<DATA><CRC>[T1-T2-T3-T4]

Where:

a) [T1-T2-T3-T4] is at least 3.5 character times of silent interval.
b) KK is the identification number.
c) 04 hex is the Modbus code "Read Analogue Registers".
d) 02 hex is the Modbus code "Read Digital Inputs".
e) ssss is the start address in the range 0000 to FFFF (0 to 63535 decimal).
f) nnnn number of registers in the range 0001 to 00FF (1 to 255 decimal).
g) bb is the number of bytes to be transferred.
h) <DATA> data nnnn items.
i) <CRC> CRC Checksum.

APPENDIX 3 GAS CHROMATOGRAPHS SUPPORTED

Table 6 Instromet Station Controller 793-7SC.

Addr.	Function	Number Format
10380	Stream Number	Double 4321 8 bytes
10381	Alarms	Double 4321 8 bytes

Unit will continue to read the above registers if the Stream Number is a required Stream and there are no communication alarms or status alarms it will then read the following data.

Addr.	Function	Number Format
10350	Superior Heating Value	Double 4321 8 bytes
10351	Inferior Heating Value	Double 4321 8 bytes
10352	Relative Density	Double 4321 8 bytes
10353	Mol % CO2	Double 4321 8 bytes
10354	Mol % N2	Double 4321 8 bytes
10360	Mol % Methane	Double 4321 8 bytes
10361	Mol % Ethane	Double 4321 8 bytes
10362	Mol % Propane	Double 4321 8 bytes
10363	Mol % i-Butane	Double 4321 8 bytes
10364	Mol % n-Butane	Double 4321 8 bytes
10365	Mol % i-Pentane	Double 4321 8 bytes
10370	Mol % n-Pentane	Double 4321 8 bytes
10371	Mol % neo-Pentane	Double 4321 8 bytes
10372	Mol % C6+	Double 4321 8 bytes
10373	Mol % H2	Double 4321 8 bytes
10374	Mol % Helium	Double 4321 8 bytes
10375	Mol % CO	Double 4321 8 bytes

APPENDIX 3 GAS CHROMATOGRAPHS SUPPORTED

Table 7 Instromet M2000 in GC Emulation mode.

Addr.	Function		Number Format
1000	GC Stream Number		unsigned short integer 4321 2 bytes
1001	Chr.Analysed stream		unsigned short integer 4321 2 bytes
1300	Chr Alarms	0 = OK	unsigned short integer 4321 2 bytes
1301	Chromat Alarm .1	0 = OK	unsigned short integer 4321 2 bytes

Unit will continue to read the above registers if the Stream Number is a required Stream and there are no communication alarms or status alarms it will then read the following data.

Addr.	Function	Number Format
1100	Relative Density	Double 4321 8 bytes
1101	Superior Heating Value	Double 4321 8 bytes
1102	Inferior Heating Value	Double 4321 8 bytes
1103	Mol % Methane	Double 4321 8 bytes
1104	Mol % N2	Double 4321 8 bytes
1105	Mol % CO2	Double 4321 8 bytes
1106	Mol % Ethane	Double 4321 8 bytes
1107	Mol % Propane	Double 4321 8 bytes
1108	Mol % H2O	Double 4321 8 bytes
1119	Mol % H2S	Double 4321 8 bytes
1110	Mol % H2	Double 4321 8 bytes
1111	Mol % CO	Double 4321 8 bytes
1112	Mol % O2	Double 4321 8 bytes
1113	Mol % i-Butane	Double 4321 8 bytes
1114	Mol % n-Butane	Double 4321 8 bytes
1115	Mol % i-Pentane	Double 4321 8 bytes
1116	Mol % n-Pentane	Double 4321 8 bytes
1117	Mol % n-Hexane	Double 4321 8 bytes
1118	Mol % n-Heptane	Double 4321 8 bytes
1119	Mol % n-Octane	Double 4321 8 bytes
1120	Mol % n-Nonane	Double 4321 8 bytes
1121	Mol % n-Decane	Double 4321 8 bytes
1122	Mol % Helium	Double 4321 8 bytes
1123	Mol % Argon	Double 4321 8 bytes
1124	Mol % neo-Pentane	Double 4321 8 bytes
1200	Wobbe index (Superior)	Double 4321 8 bytes
1201	Wobbe index (Inferior)	Double 4321 8 bytes
1202	Mol % C6+	Double 4321 8 bytes

APPENDIX 3 GAS CHROMATOGRAPHS SUPPORTED

Table 8 ABB Model 3100.

Unit will read the following Coil addresses, to determine what mode the Analyser is in Coil Addresses Read using Modbus Function 01

Address	Function	
1	Analyser Available	0 = Not Available 1 = Available
2001	New Data Available	0 = Not Available 1 = Available
101	Analyser in Cal Mode	0 = Not in Cal Mode 1= In Cal Mode

If it is not available or in the Cal mode or no new data is available, then the unit will continue to read those coils until the Analyser is available, and is not in cal mode and new data is available.
Then it will read Gas Coil Data and Gas Register Data, any Not Valid components will not be used and the FC2000 default will be used instead. All Valid Data will be used.

3001	C5+ Valid flag	0 = Not Valid 1= Valid
3002	N2 Valid Flag	0 = Not Valid 1= Valid
3003	Methane Valid Flag	0 = Not Valid 1= Valid
3004	CO2 Valid Flag	0 = Not Valid 1= Valid
3005	Ethane Valid Flag	0 = Not Valid 1= Valid
3006	Propane Valid Flag	0 = Not Valid 1= Valid
3007	i Butane Valid Flag	0 = Not Valid 1= Valid
3008	n Butane Valid Flag	0 = Not Valid 1= Valid
3009	Gross Heating Valid Flag	0 = Not Valid 1= Valid
3010	Normal Heating Value Valid Flag	0 = Not Valid 1= Valid
3011	SG Value Valid Flag	0 = Not Valid 1= Valid
3012	Sum of Components Valid Flag	0 = Not Valid 1= Valid

Register addresses Read using Modbus Function 03 Returns a 16 bit Unsigned Integer Value Scaled 0 to 9999

Address	Function	Units	Scale Full Scale
3002	C5+	Molar %	2%
3003	N2	Molar %	2%
3004	Methane	Molar %	100%
3005	CO2	Molar %	5%
3006	Ethane	Molar %	5%
3007	Propane	Molar %	2%
3008	i Butane	Molar %	1%
3009	n Butane	Molar %	1%
3010	Gross Heating Value	BTU	10000 BTU
3011	Normal Heating Value	BTU	10000 BTU
3012	SG		2
3013	Sum of Components	%	2

APPENDIX 4 CONNECTOR PIN IDENTIFICATION

APPENDIX 4

CONNECTOR PIN IDENTIFICATION FOR INPUT AND OUTPUT SIGNALS

SOCKET No SKT 1 — RS232/RS485 SIGNALS COMMS PORT 1
9 Pin Female

D type Pin No.	FUNCTION	Signal Direction
1	not to be used	
2	RS232 RxD	2000 ⇐ PC
3	RS232 TxD	2000 ⇒ PC
4	not to be used	
5	RS232 0V Common	
6	RS485 B	
7	RS 232 RTS	2000 ⇒ PC
8	RS 232 CTS	2000 ⇐ PC
9	RS485 A	

CONNECTOR PIN IDENTIFICATION FOR INPUT AND OUTPUT SIGNALS

SOCKET No SKT 2 — RS232/RS485 SIGNALS COMMS PORT 2
9 Pin Female

D type Pin No.	FUNCTION	Signal Direction
1	not to be used	
2	RS232 RxD	2000 ⇐ PC
3	RS232 TxD	2000 ⇒ PC
4	not to be used	
5	RS232 0V Common	
6	RS485 B	
7	RS 232 RTS	2000 ⇒ PC
8	RS 232 CTS	2000 ⇐ PC
9	RS485 A	

CONNECTOR PIN IDENTIFICATION FOR INPUT AND OUTPUT SIGNALS

SOCKET No SKT 3 — RS232/RS485 SIGNALS COMMS PORT 3
9 Pin Female

D type Pin No.	FUNCTION	Signal Direction
1	not to be used	
2	RS232 RxD	2000 ⇐ PC
3	RS232 TxD	2000 ⇒ PC
4	not to be used	
5	RS232 0V Common	
6	RS485 B	
7	RS 232 RTS	2000 ⇒ PC
8	RS 232 CTS	2000 ⇐ PC
9	RS485 A	

APPENDIX 4 CONNECTOR PIN IDENTIFICATION

CONNECTOR PIN IDENTIFICATION FOR INPUT AND OUTPUT SIGNALS

SOCKET No SKT 4 — RS232/RS485 SIGNALS COMMS PORT 4

9 Pin Female

D type Pin No.	FUNCTION	Signal Direction
1	not to be used	
2	RS232 RxD	2000 ⇐ PC
3	RS232 TxD	2000 ⇒ PC
4	not to be used	
5	RS232 0V Common	
6	RS485 B	
7	RS 232 RTS	2000 ⇒ PC
8	RS 232 CTS	2000 ⇐ PC
9	RS485 A	

INPUT MODULE TERMINAL CONNECTIONS

Terminal No.	FUNCTION	Terminal No.	FUNCTION
A1	Status Input 1 LED +	B1	High Freq. Input 2 LED +
A2	Status Input 1 LED –	B2	High Freq. Input 2 LED –
A3	Status Input 3 LED +	B3	Status Input 2 LED +
A4	Status Input 3 LED –	B4	Status Input 2 LED –
A5	High Freq. Input 1 LED +	B5	HART Loop 1 +
A6	High Freq. Input 1 LED –	B6	HART Loop 1 –
A7	0V24	B7	HART Loop 2 +
A8	0V24	B8	HART Loop 2 –
A9	+24V dc Auxiliary Supply	B9	4-20mA Input 2 –
A10	+24V dc Auxiliary Supply	B10	4-20mA Input 2 +
A11	+24V dc Auxiliary Supply	B11	4-20mA Input 4 –
A12	+24V dc Auxiliary Supply	B12	4-20mA Input 4 +
A13	not to be used	B13	4-20mA Input 1 –
A14	PRT Input C	B14	4-20mA Input 1 +
A15	PRT Input B	B15	4-20mA Input 3 –
A16	PRT Input A	B16	4-20mA Input 3 +

APPENDIX 4 CONNECTOR PIN IDENTIFICATION

PRT INPUT MODULE TERMINAL CONNECTIONS

Terminal No.	FUNCTION	Terminal No.	FUNCTION
A1	Status Input 1 LED +	B1	High Freq. Input 2 LED +
A2	Status Input 1 LED –	B2	High Freq. Input 2 LED –
A3	Status Input 3 LED +	B3	Status Input 2 LED +
A4	Status Input 3 LED –	B4	Status Input 2 LED –
A5	High Freq. Input 1 LED +	B5	HART Loop 1 +
A6	High Freq. Input 1 LED –	B6	HART Loop 1 –
A7	0V24	B7	HART Loop 2 +
A8	0V24	B8	HART Loop 2 –
A9	+24V dc Auxiliary Supply	B9	not to be used
A10	+24V dc Auxiliary Supply	B10	not to be used
A11	+24V dc Auxiliary Supply	B11	not to be used
A12	+24V dc Auxiliary Supply	B12	not to be used
A13	PRT Input 2 A	B13	PRT Input 1 A
A14	PRT Input 2 B	B14	PRT Input 1 B
A15	PRT Input 2 C	B15	PRT Input 1 C
A16	PRT Input 2 D	B16	PRT Input 1 D

INPUT 2 BOARD MODULE TERMINAL CONNECTIONS

Terminal No.	FUNCTION	Terminal No.	FUNCTION
A1	Status Input 1 LED +	B1	High Freq. Input 2 LED +
A2	Status Input 1 LED –	B2	High Freq. Input 2 LED –
A3	Status Input 3 LED +	B3	Status Input 2 LED +
A4	Status Input 3 LED –	B4	Status Input 2 LED –
A5	High Freq. Input 1 LED +	B5	HART Loop 1 +
A6	High Freq. Input 1 LED –	B6	HART Loop 1 –
A7	0V24	B7	HART Loop 2 +
A8	0V24	B8	HART Loop 2 –
A9	+24V dc Auxiliary Supply	B9	4-20mA Input 2 –
A10	+24V dc Auxiliary Supply	B10	4-20mA Input 2 +
A11	+24V dc Auxiliary Supply	B11	4-20mA Input 4 –
A12	No Function	B12	4-20mA Input 4 +
A13	No Function	B13	4-20mA Input 1 –
A14	PRT Input C	B14	4-20mA Input 1 +
A15	PRT Input B	B15	4-20mA Input 3 –
A16	PRT Input A	B16	4-20mA Input 3 +

APPENDIX 4 CONNECTOR PIN IDENTIFICATION

OUTPUT MODULE TERMINAL CONNECTIONS

Terminal No.	FUNCTION	Terminal No.	FUNCTION
A1	Switch O/P 1 Transistor Collector	B1	Switch O/P 1 Transistor Emitter
A2	Switch O/P 2 Transistor Collector	B2	Switch O/P 2 Transistor Emitter
A3	Switch O/P 3 Transistor Collector	B3	Switch O/P 3 Transistor Emitter
A4	Switch O/P 4 Transistor Collector	B4	Switch O/P 4 Transistor Emitter
A5	Switch O/P 5 Transistor Collector	B5	Switch O/P 5 Transistor Emitter
A6	Switch O/P 6 Transistor Collector	B6	Switch O/P 6 Transistor Emitter
A7	Switch O/P 7 Transistor Collector	B7	Switch O/P 7 Transistor Emitter
A8	Switch O/P 8 Transistor Collector	B8	Switch O/P 8 Transistor Emitter
A9	Switch O/P 9 Transistor Collector	B9	Switch O/P 9 Transistor Emitter
A10	Switch O/P 10 Transistor Collector	B10	Switch O/P 10 Transistor Emitter
A11	Switch O/P 11 Transistor Collector	B11	Switch O/P 11 Transistor Emitter
A12	Switch O/P 12 Transistor Collector	B12	Switch O/P 12 Transistor Emitter
A13	Current O/P 1 +	B13	Current O/P 1 -
A14	Current O/P 2 +	B14	Current O/P 2 -
A15	Current O/P 3 +	B15	Current O/P 3 -
A16	Current O/P 4 +	B16	Current O/P 4 -

APPENDIX 4 CONNECTOR PIN IDENTIFICATION

POWER SUPPLY INPUT CONNECTOR

Terminal No.	FUNCTION	
1	+24V	+24V dc positive power supply Terminal
2	E	Earth connection terminal
3	0V24	Power Supply 0V terminal

AUXILIARY POWER SUPPLY OUTPUT CONNECTOR

Terminal No.	FUNCTION	
1	+24V	+24V dc positive power supply Terminal
2	E	Earth connection terminal
3	0V24	Power Supply 0V terminal
		Earth Stud terminal

APPENDIX 5

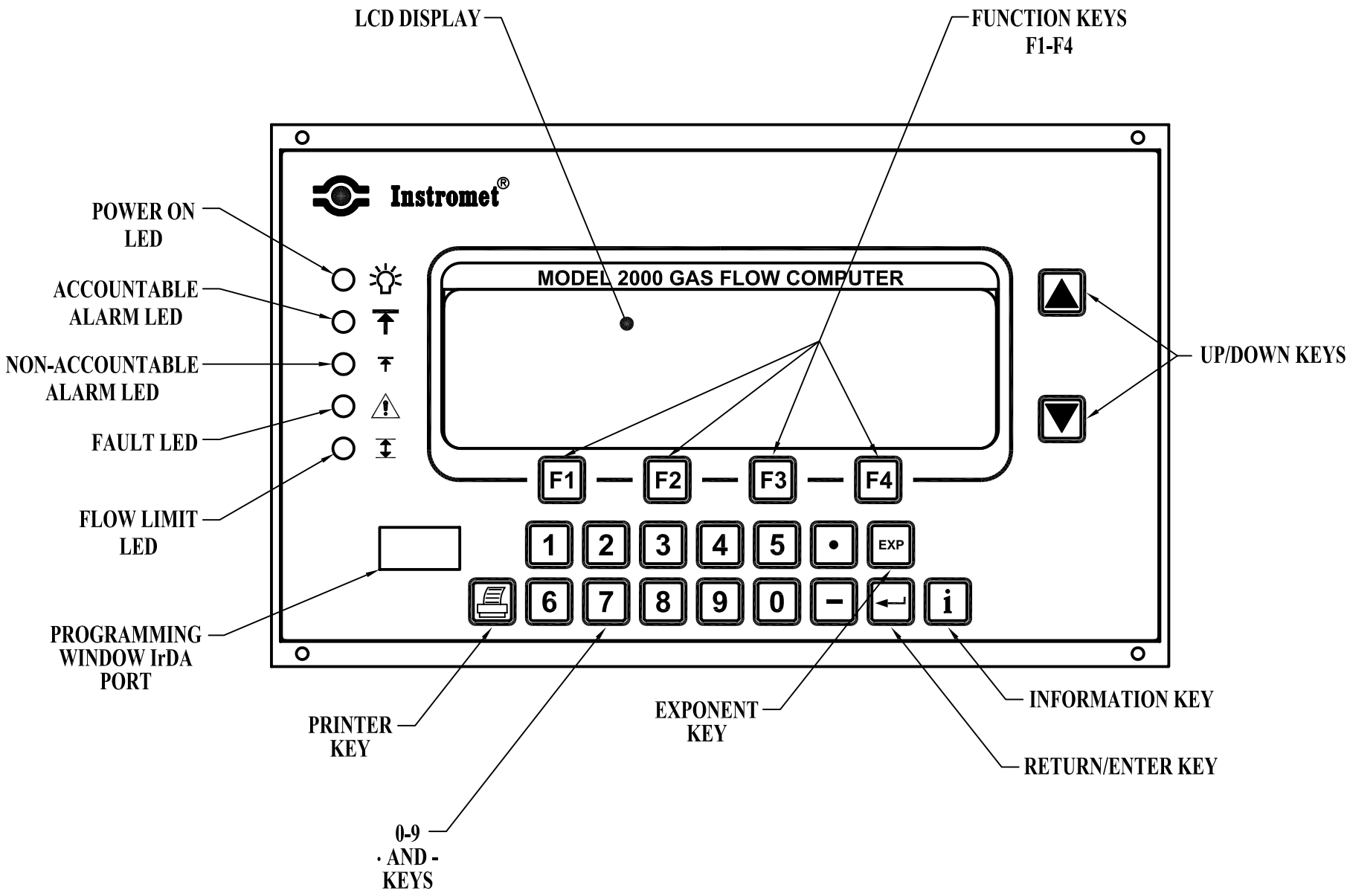
APPENDIX 5

Micro Motion Modbus List

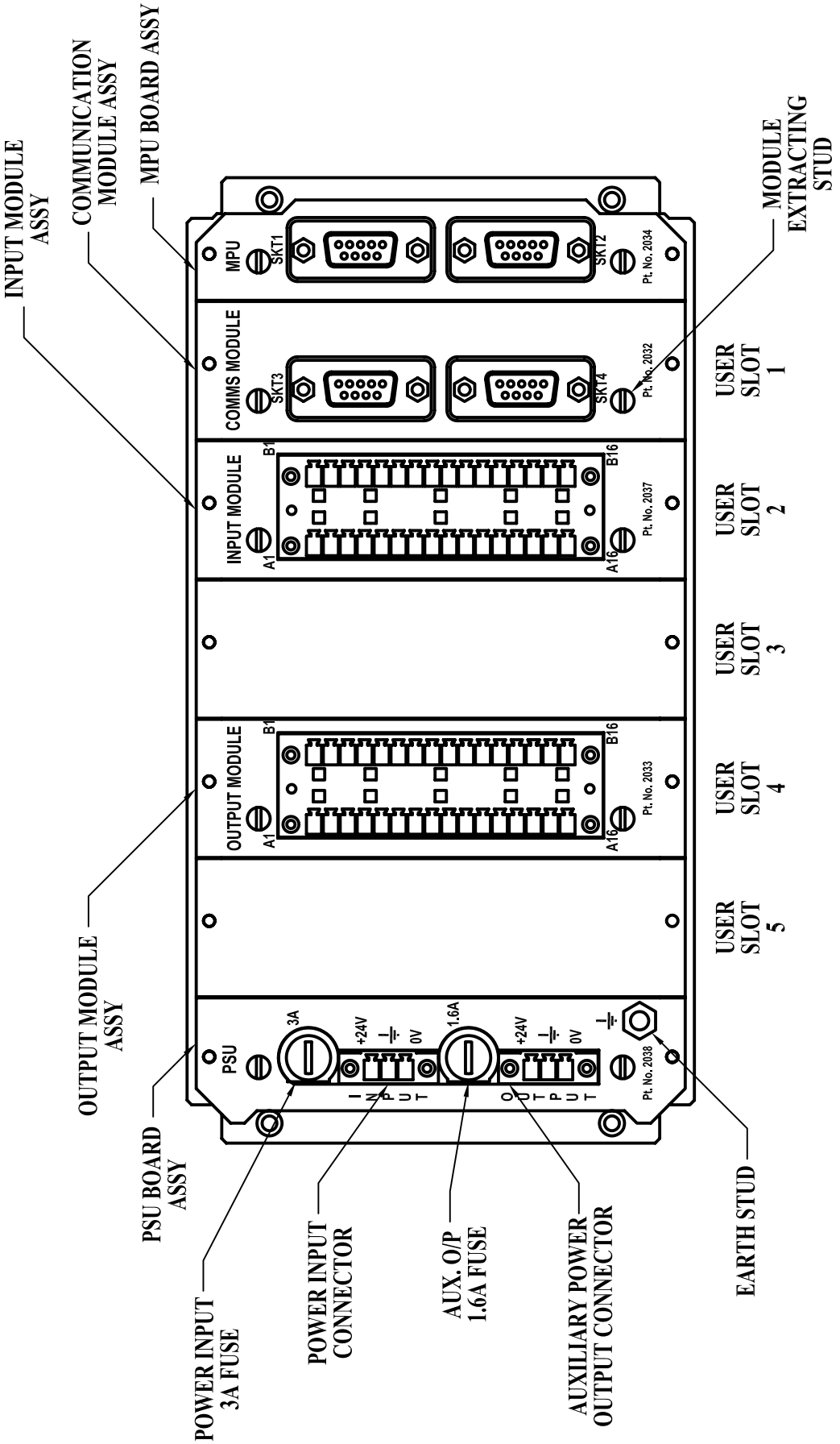
Address	Type	Size (Bytes)	Name	Num. Registers	Register Size	Action
38	16 bit U.Int	2	Flow Units (Mass)	1	2	R/W
44	16 bit U.Int	2	Total Units (Mass)	1	2	R/W
41	16 bit U.Int	2	Flow Units (Volume)	1	2	R/W
45	16 bit U.Int	2	Total Units (Volume)	1	2	R/W
39	16 bit U.Int	2	Density Units	1	2	R/W
43	16 bit U.Int	2	Pressure Units	1	2	R/W
40	16 bit U.Int	2	Temperature Units	1	2	R/W
13	16 bit U.Int	2	pulse output variable	1	2	R/W
222	32 bit Float	4	select scaling method	2	2	R/W
224	32 bit Float	4	configure scaling	2	2	R/W
226	32 bit Float	4	configure pulse length	2	2	R/W
244	32 bit Float	4	Alarm	2	2	W
7	16 bit U.Int	2	Reset Counters	1	2	W
9	16 bit U.Int	2	Reset Counters	1	2	W
244	32 bit U.Int	4	Status	2	2	R
246	32 bit Float	4	Mass Flow	2	2	R
248	32 bit Float	4	Density	2	2	R
250	32 bit Float	4	Temperature	2	2	R
252	32 bit Float	4	Volume Flow	2	2	R
256	32 bit Float	4	Pressure	2	2	R
258	32 bit Float	4	Mass Total	2	2	R
260	32 bit Float	4	Volume Total	2	2	R
262	32 bit Float	4	Mass Invent	2	2	R
264	32 bit Float	4	Volume Invent	2	2	R

FIGURE LIST

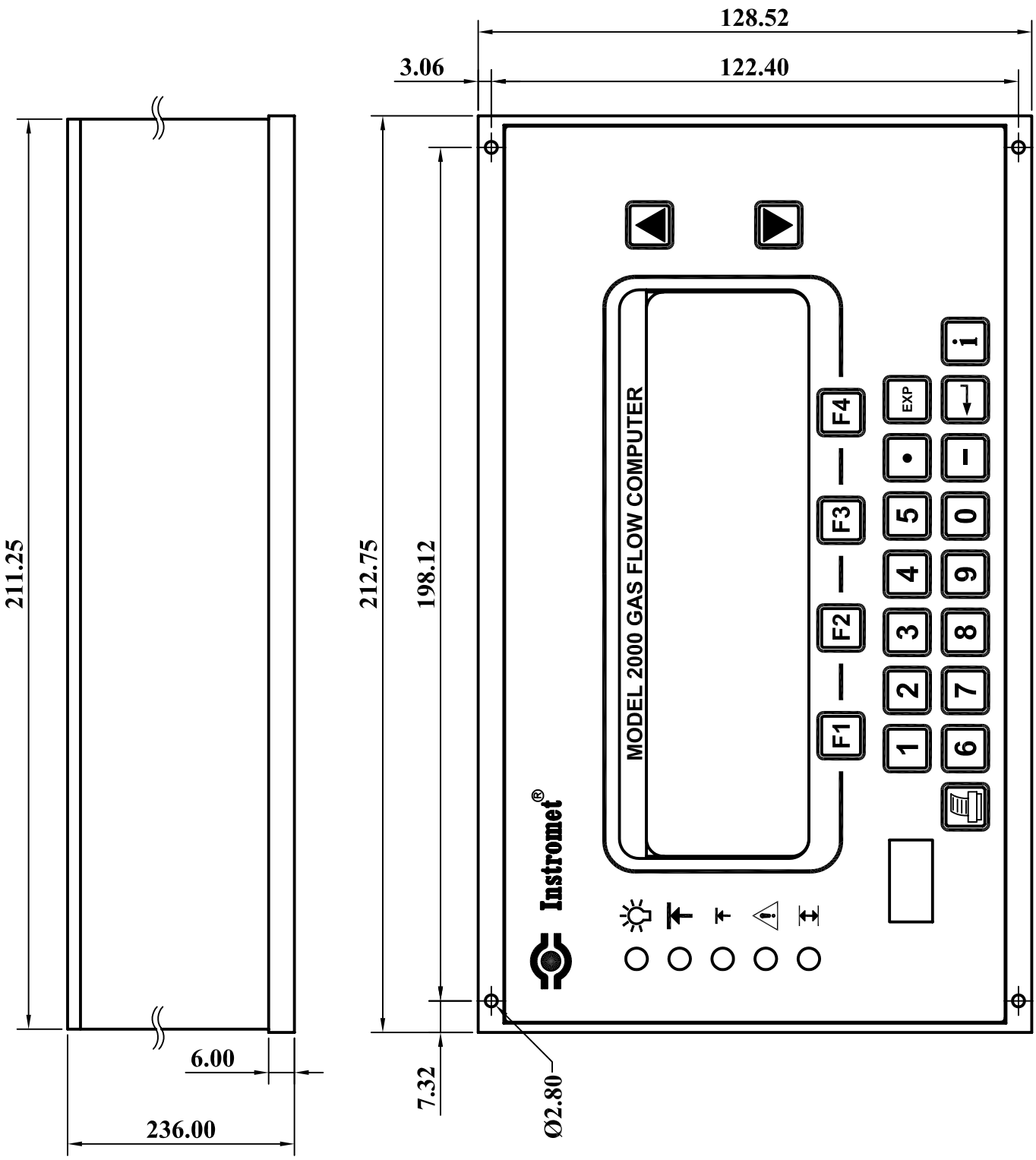
FIGURE LIST



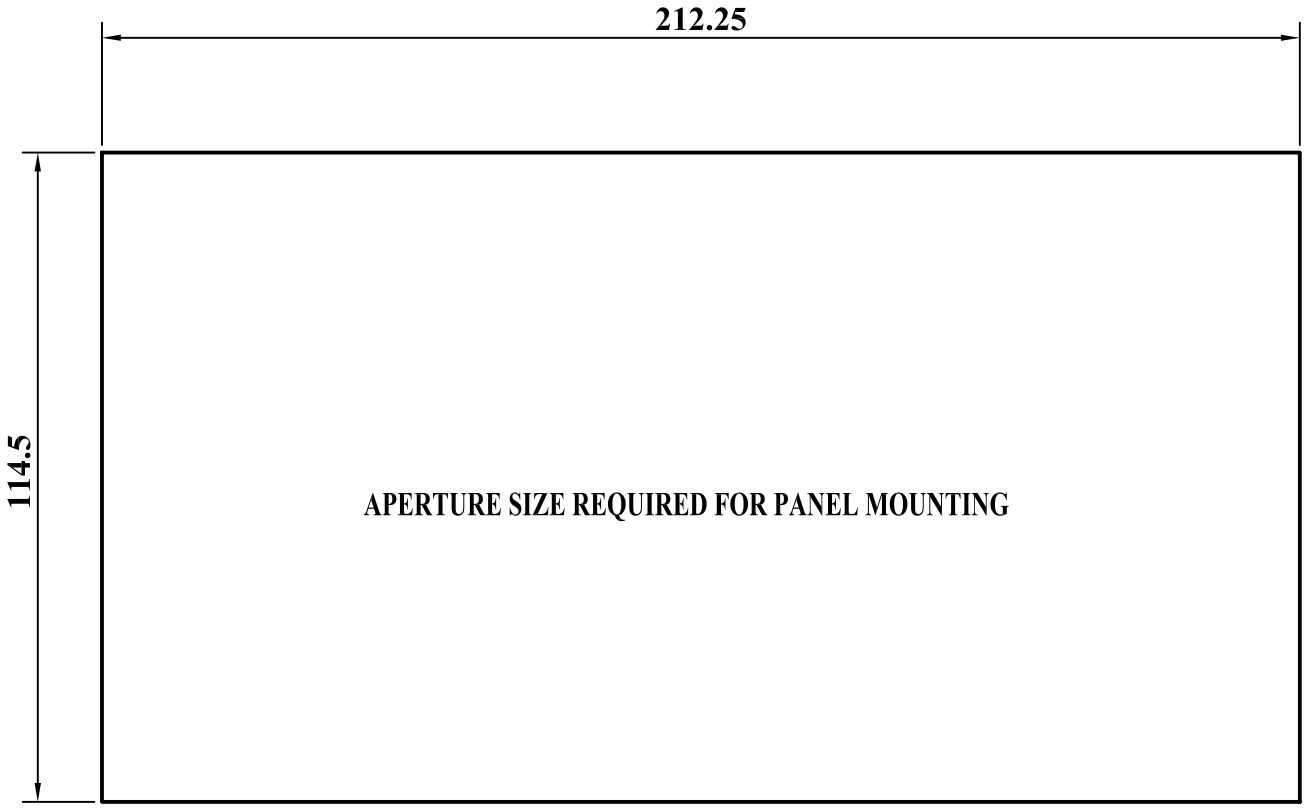
FRONT PANEL LAYOUT
FIGURE 1



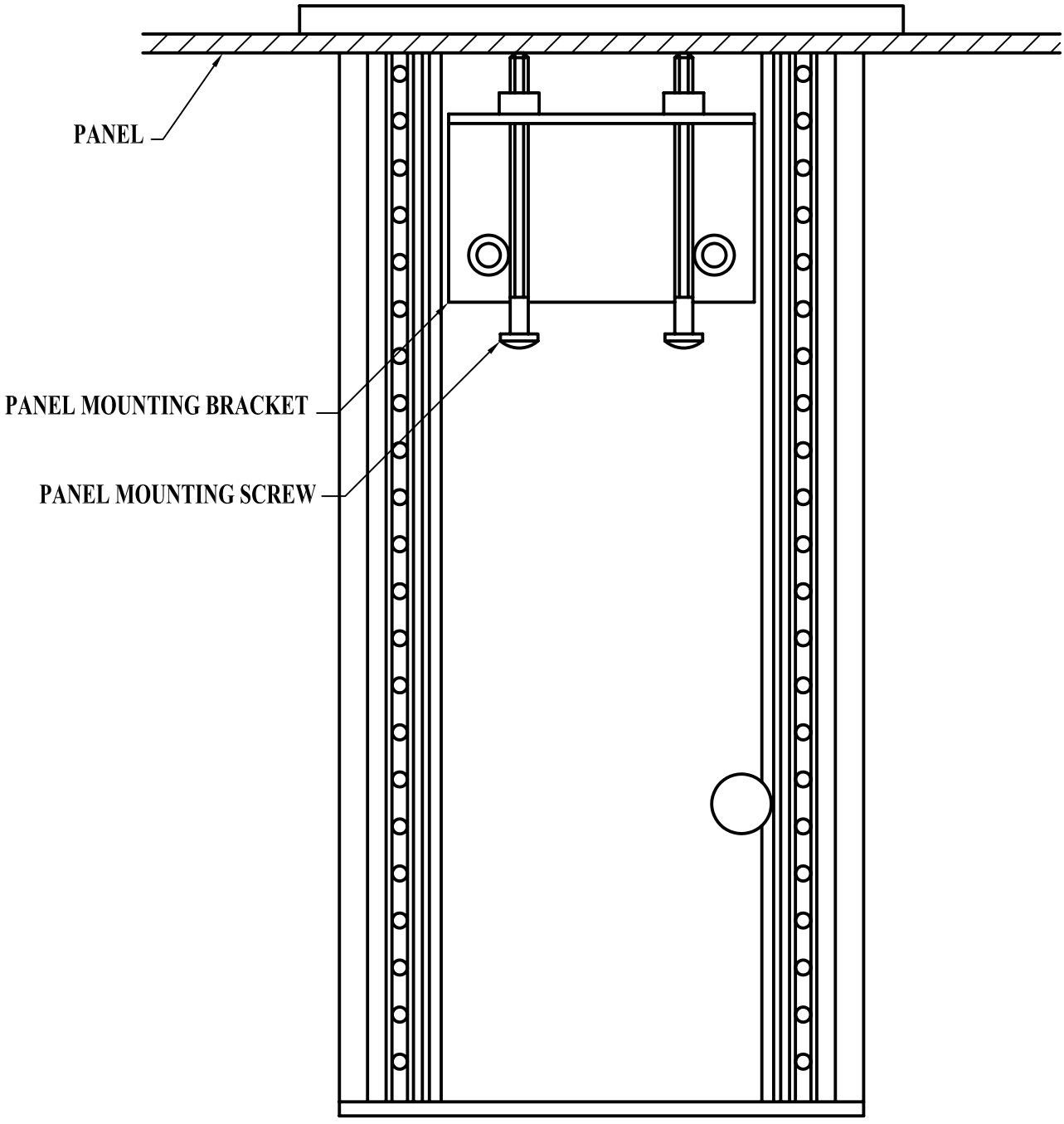
REAR PANEL SHOWING CONNECTIONS
FIGURE 2



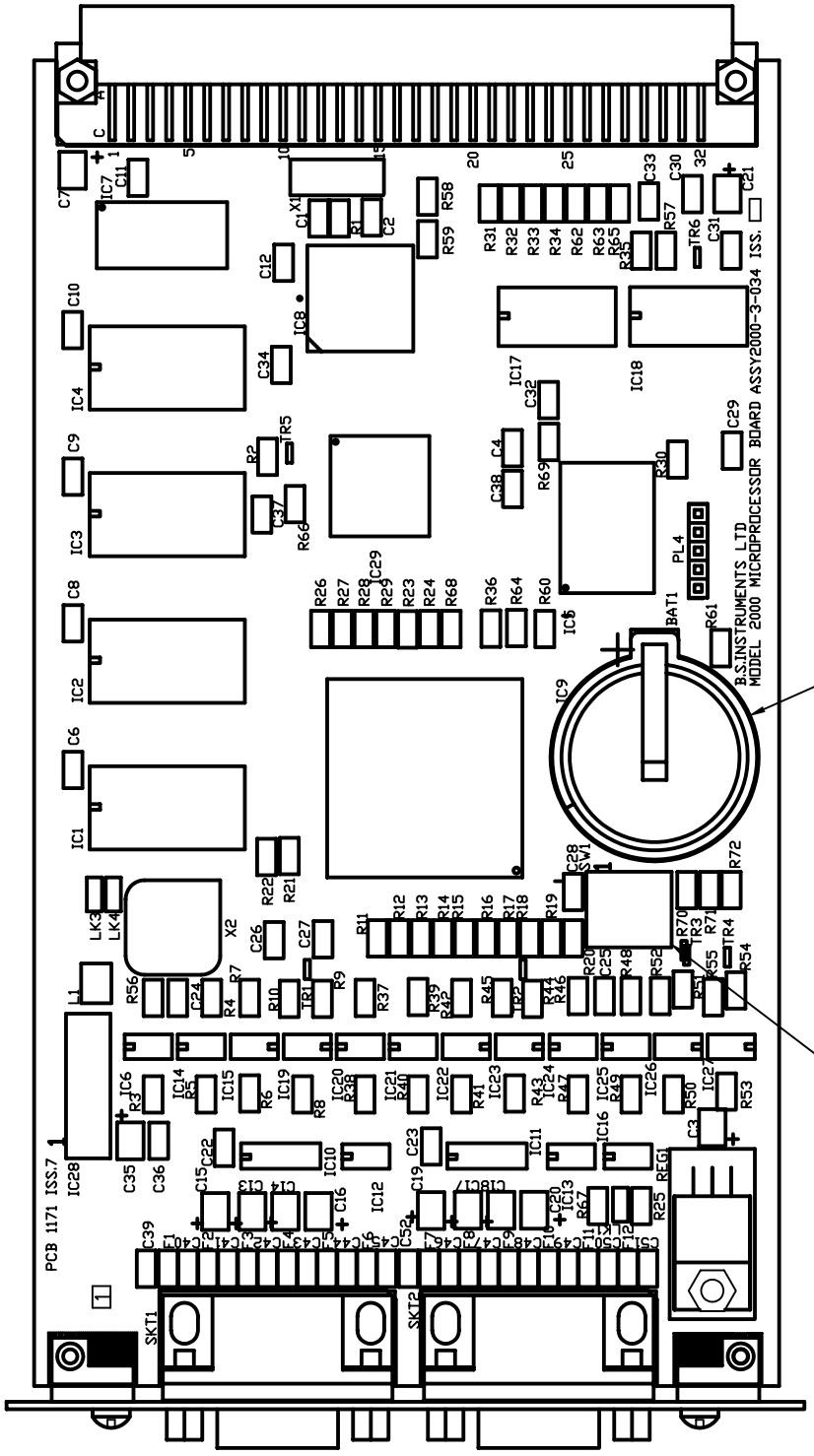
MODEL 2000 DIMENSIONS
FIGURE 3



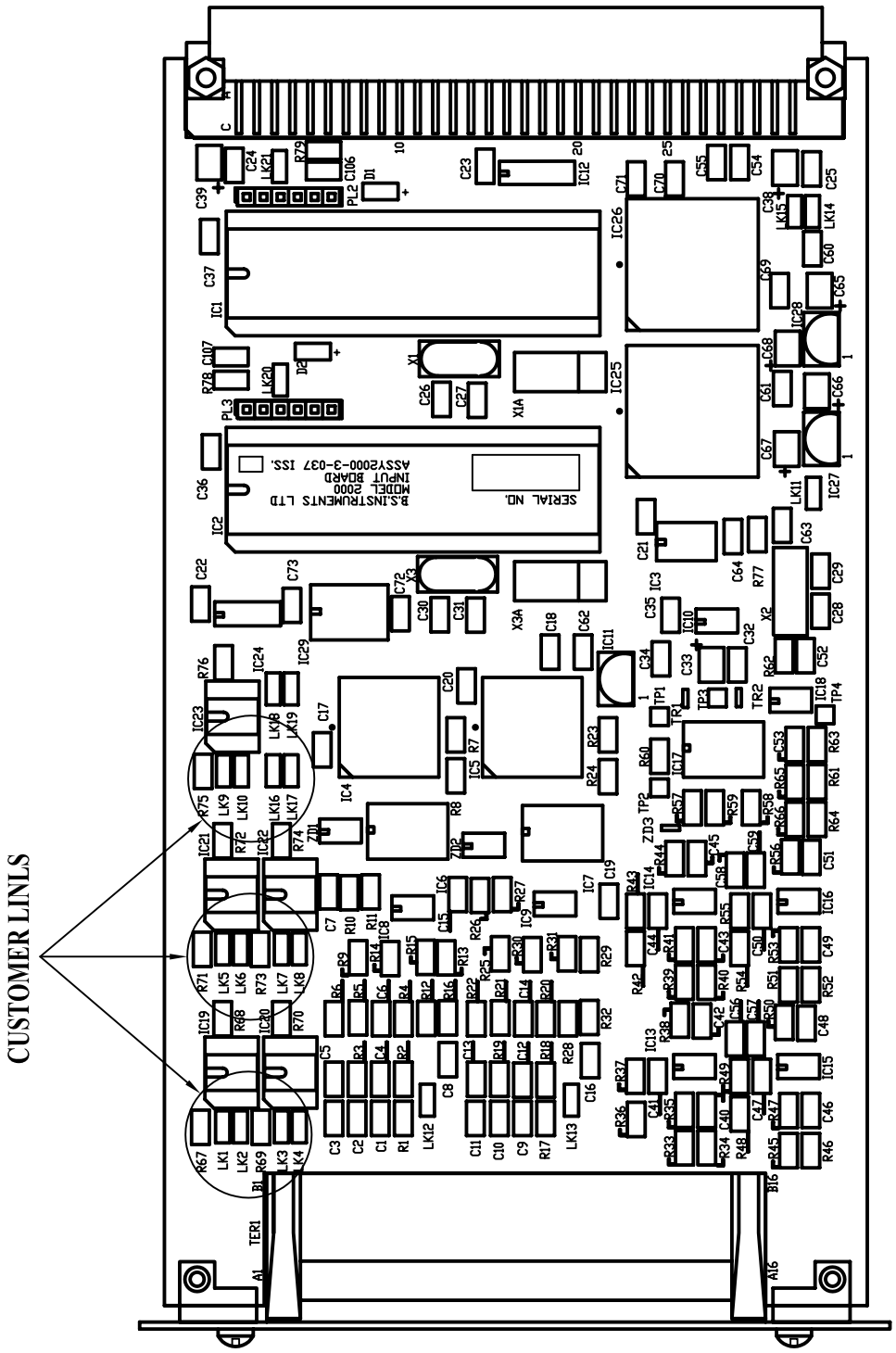
CUTOUT FOR PANEL MOUNTING
FIGURE 4



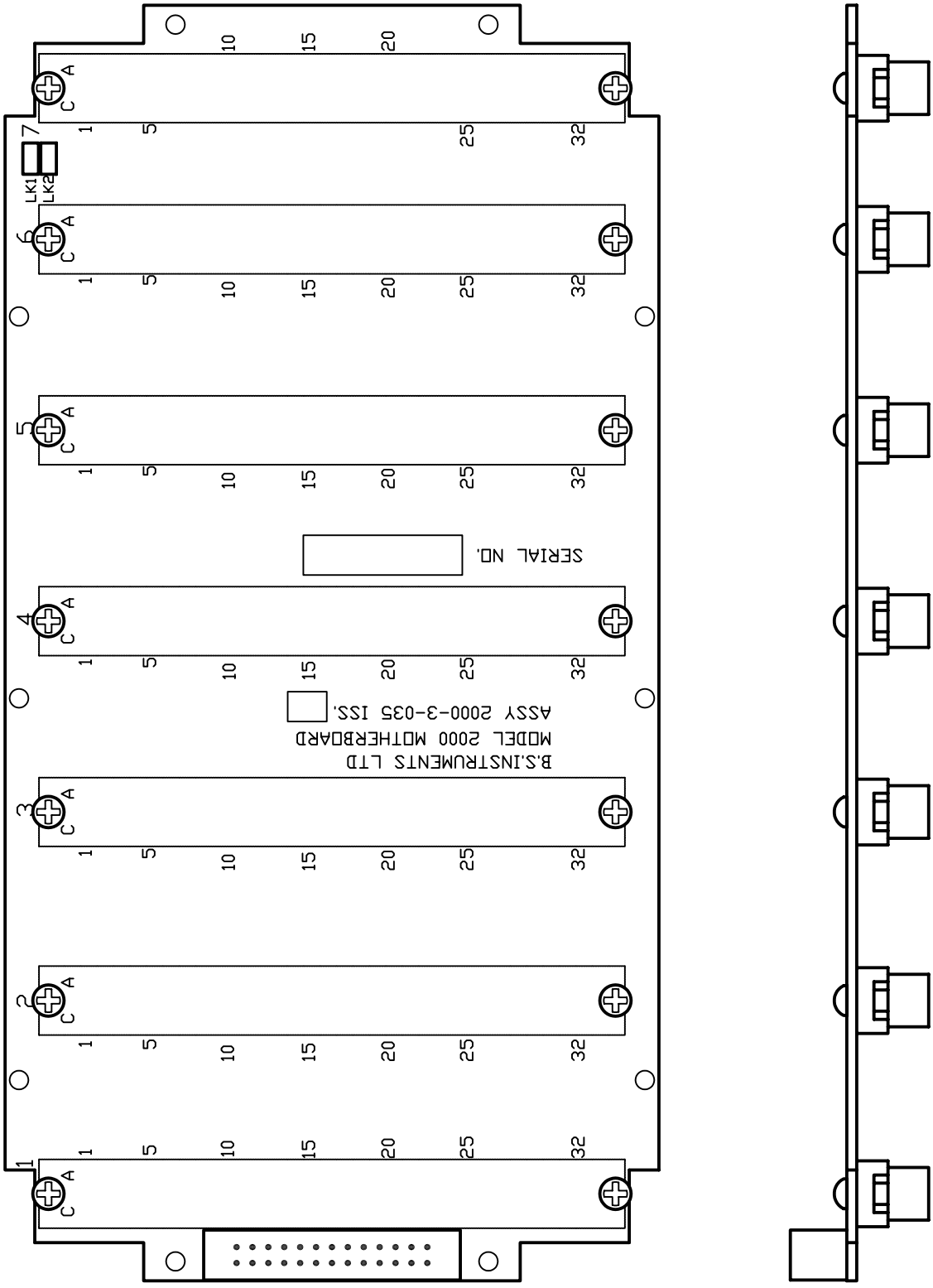
PANEL MOUNTING DETAILS
FIGURE 5



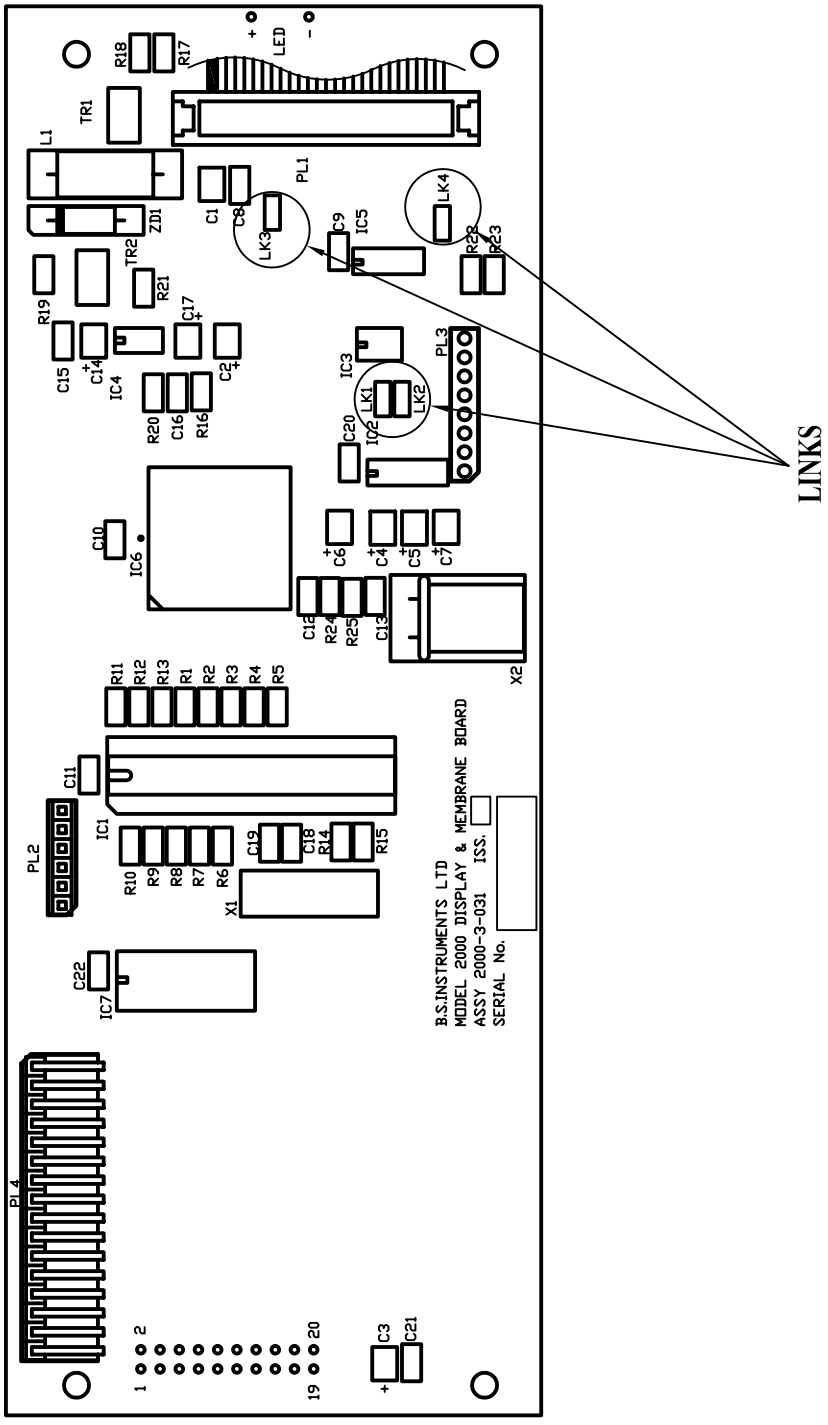
MICROPROCESSOR BOARD
FIGURE 6



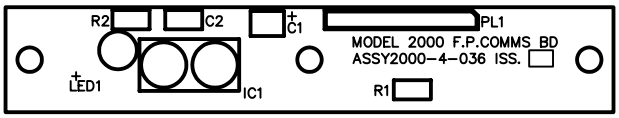
INPUT BOARD
FIGURE 7



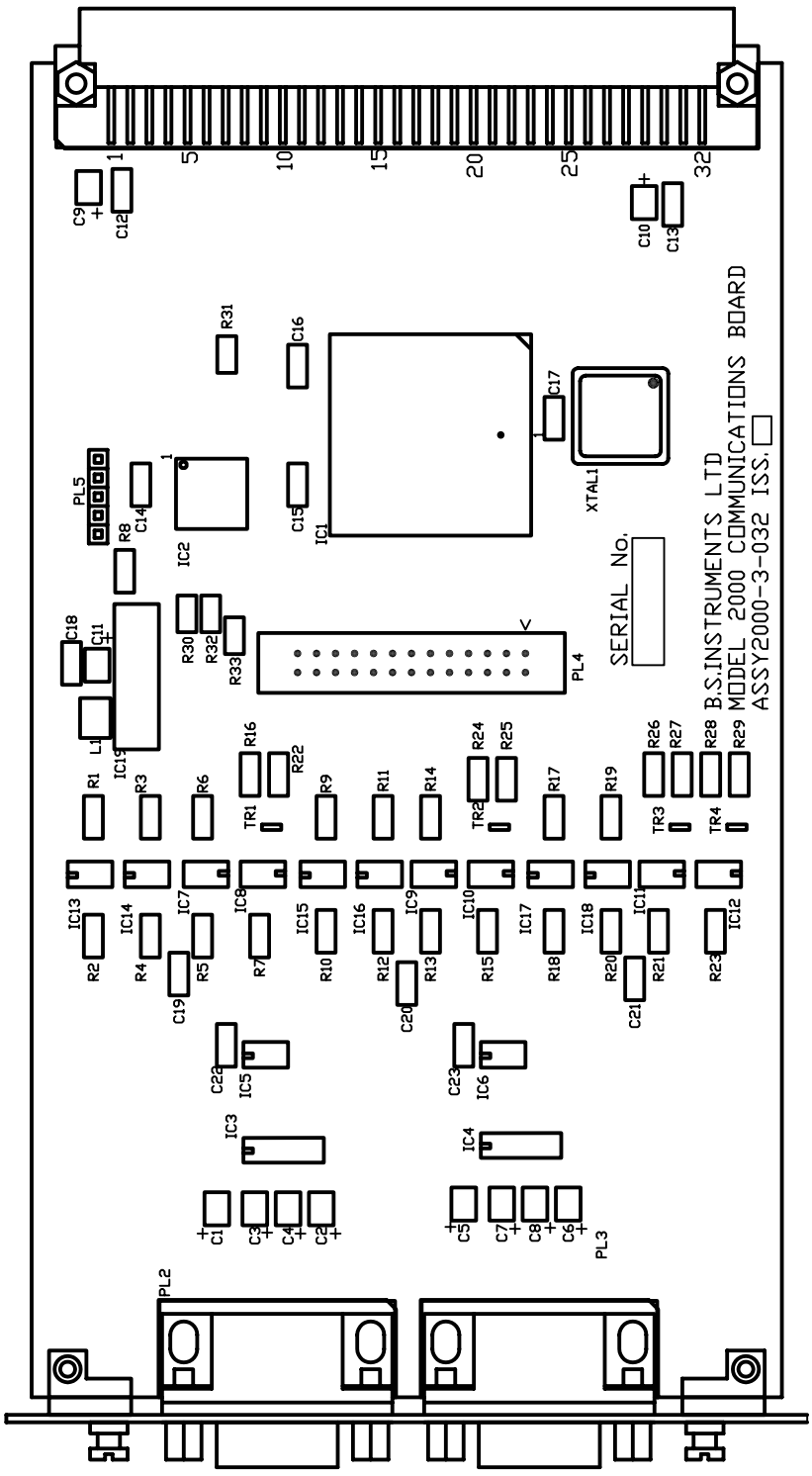
MOTHER BOARD
FIGURE 8



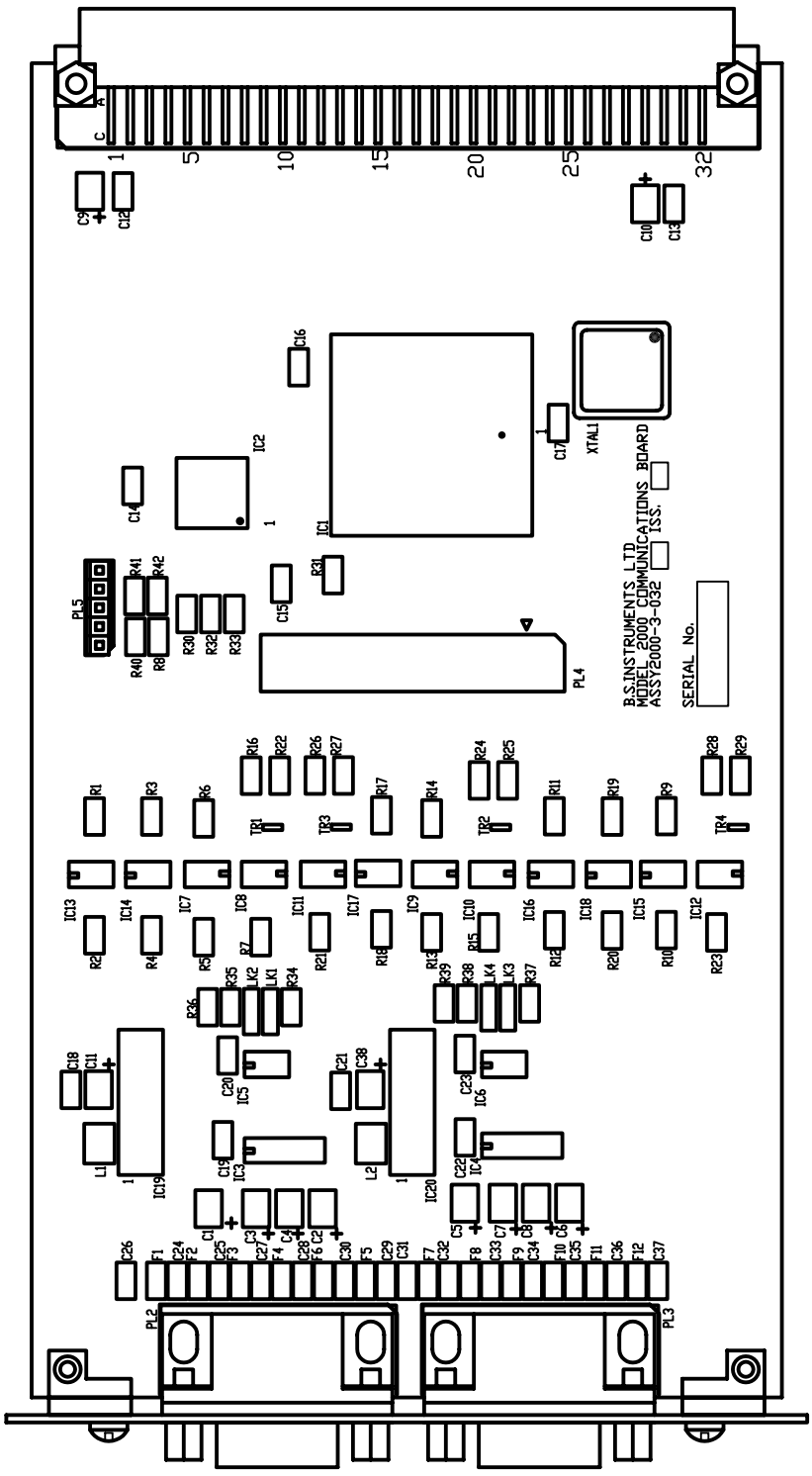
DISPLAY BOARD
FIGURE 9



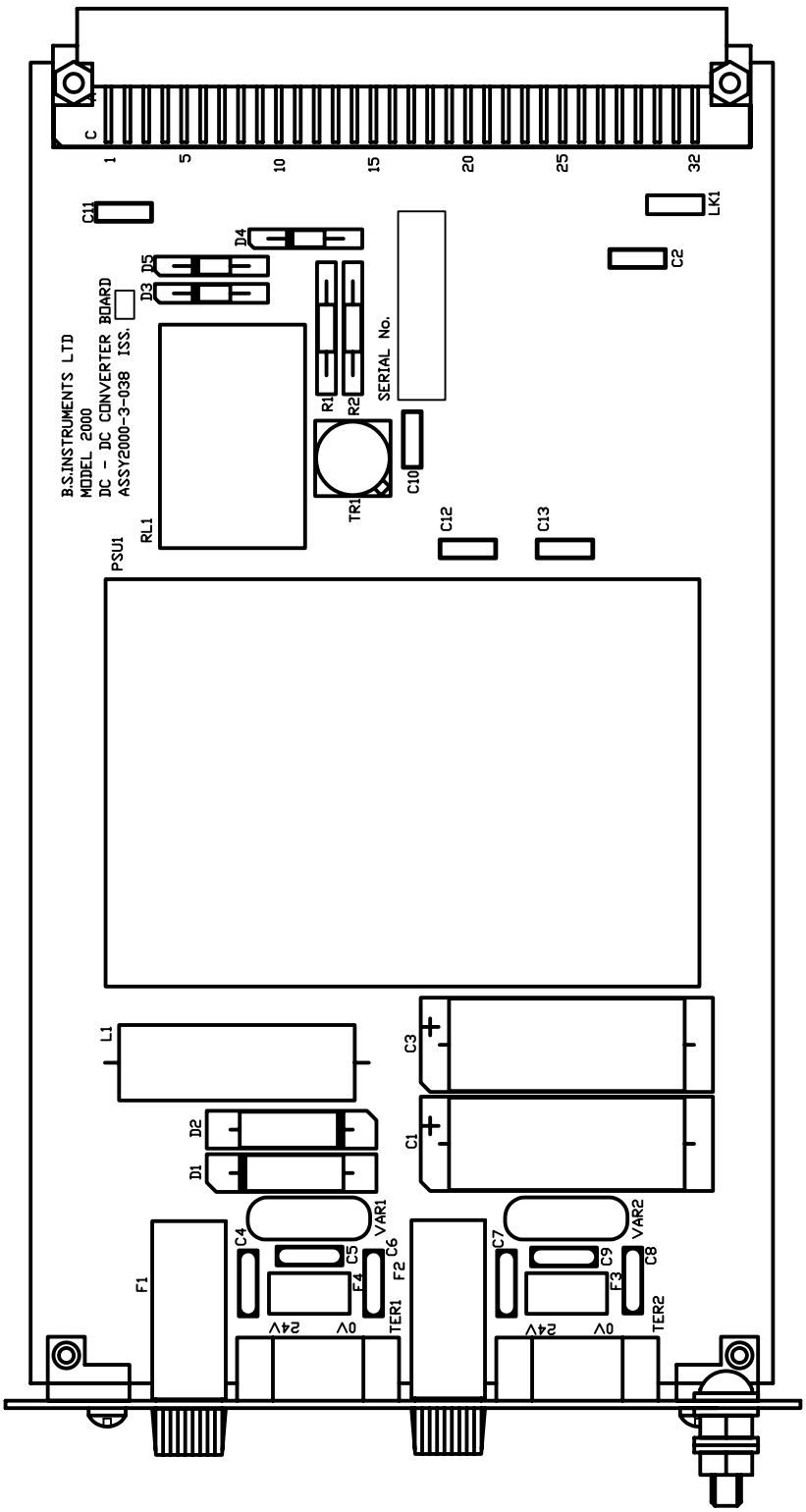
FRONT PANEL COMMUNICATIONS BOARD
FIGURE 10



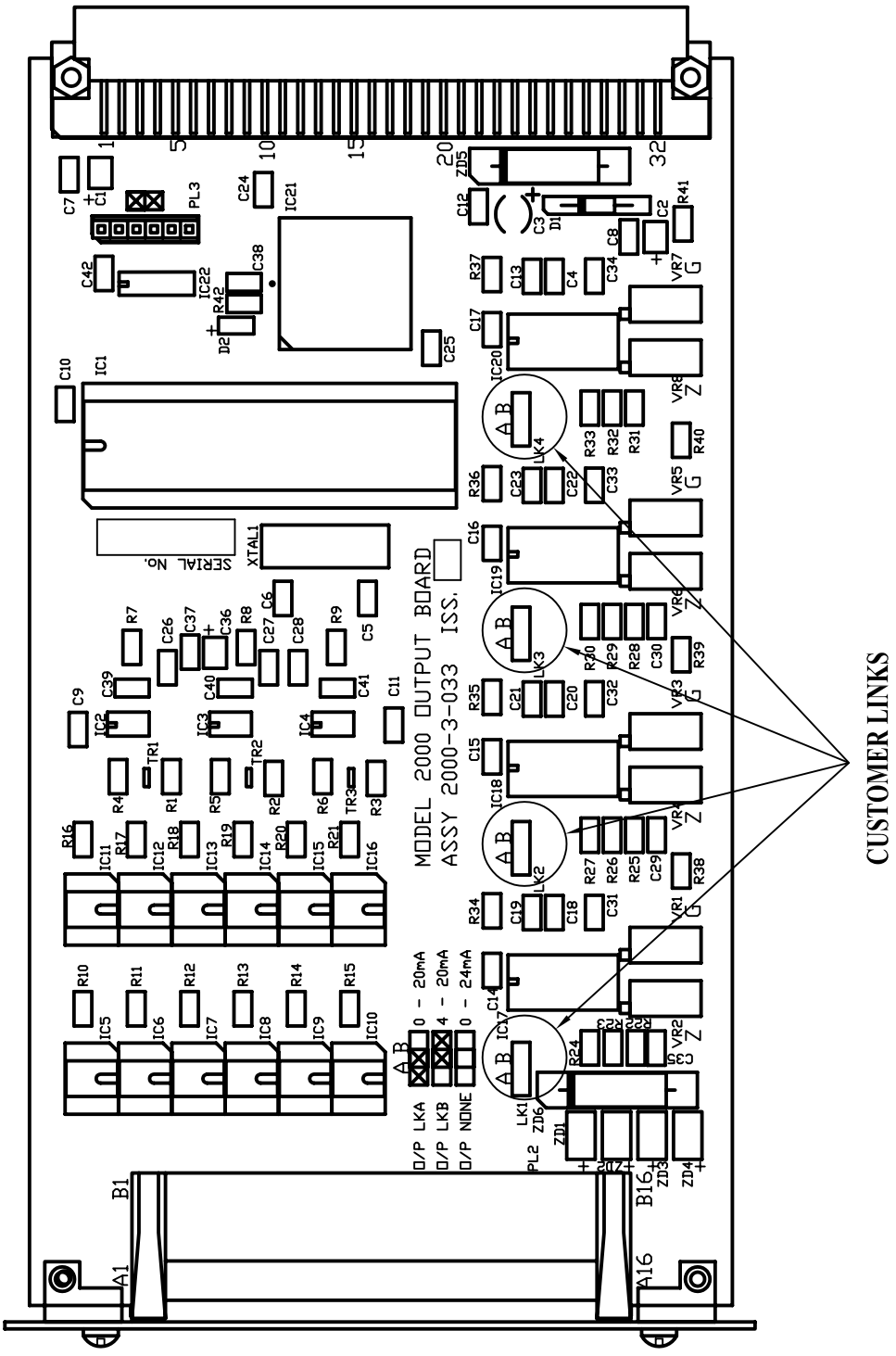
COMMUNICATIONS BOARD (ASSY 2000-3-032 ISSUE 1-4)
FIGURE 11



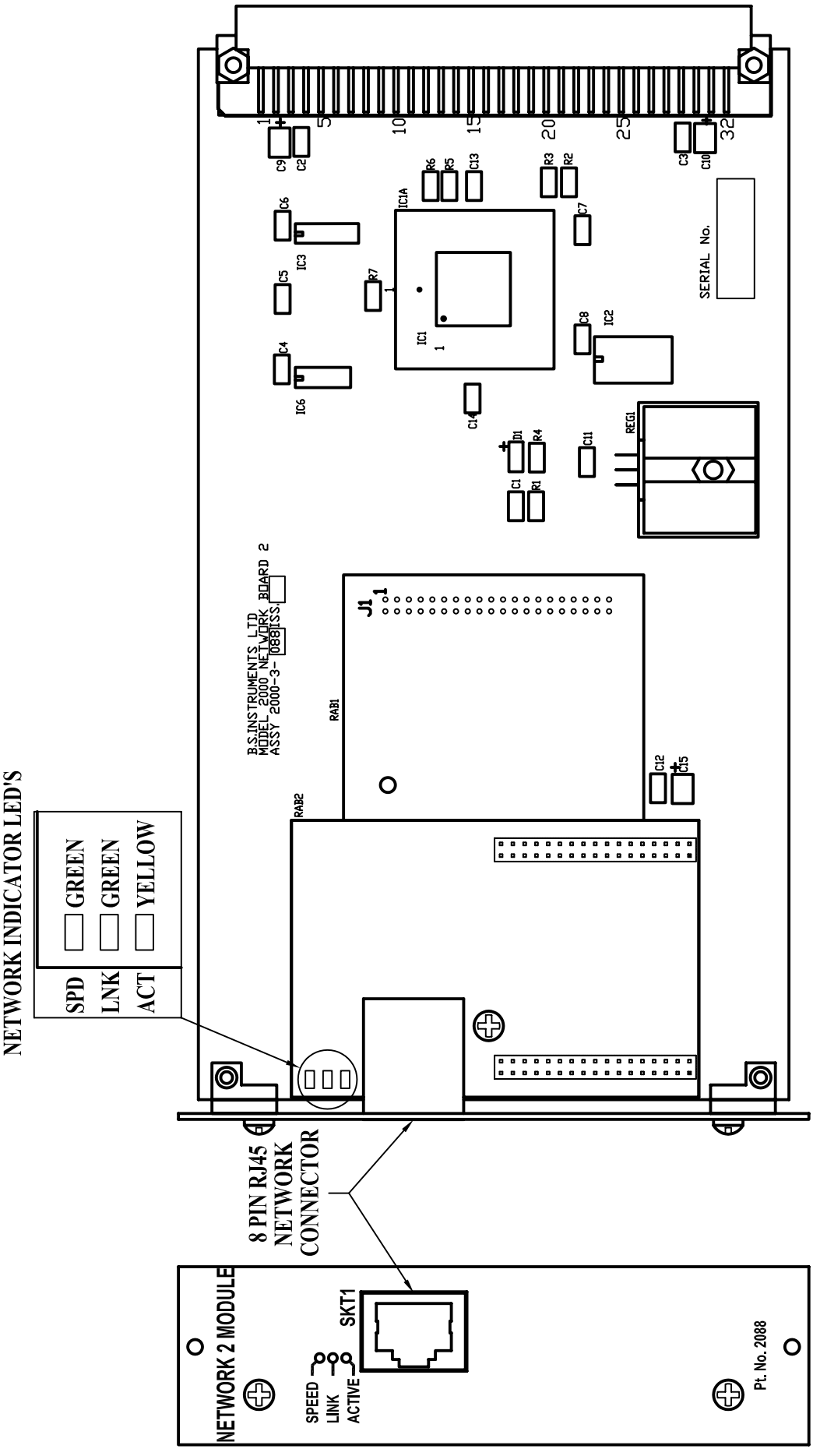
COMMUNICATIONS BOARD (ASSY 2000-3-032 ISSUE 5)
FIGURE 11A



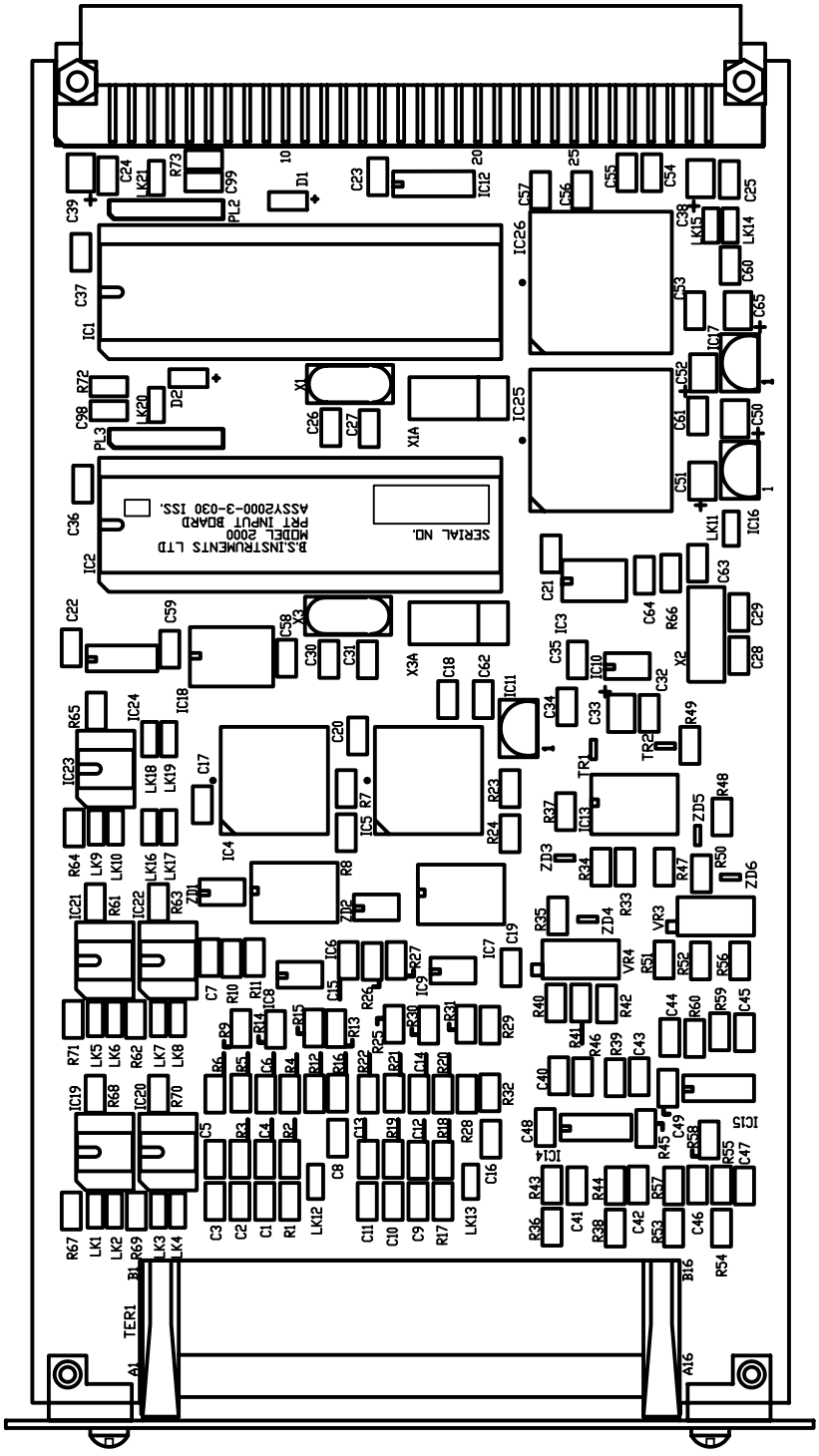
POWER SUPPLY BOARD
FIGURE 12



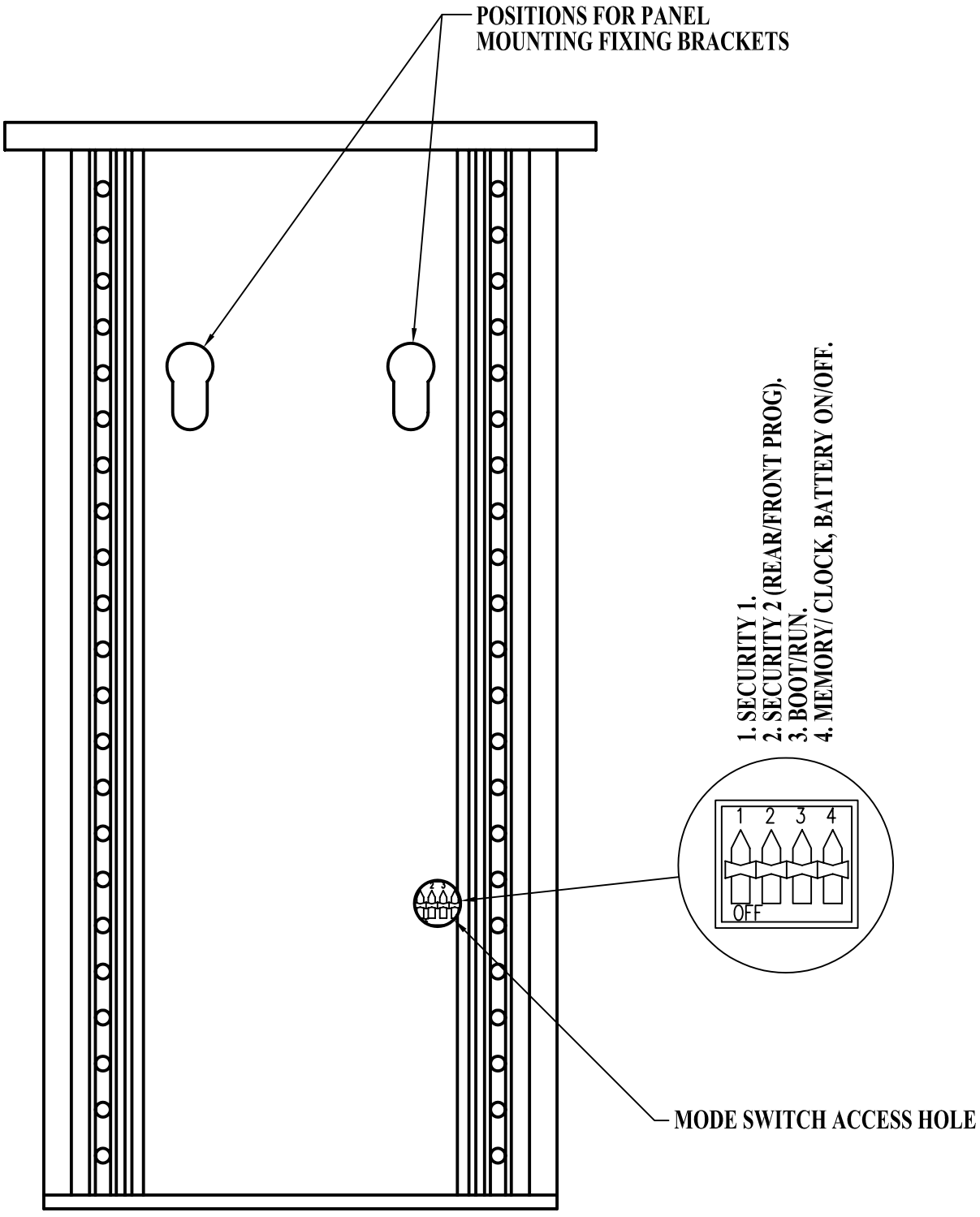
OUTPUT BOARD
FIGURE 13



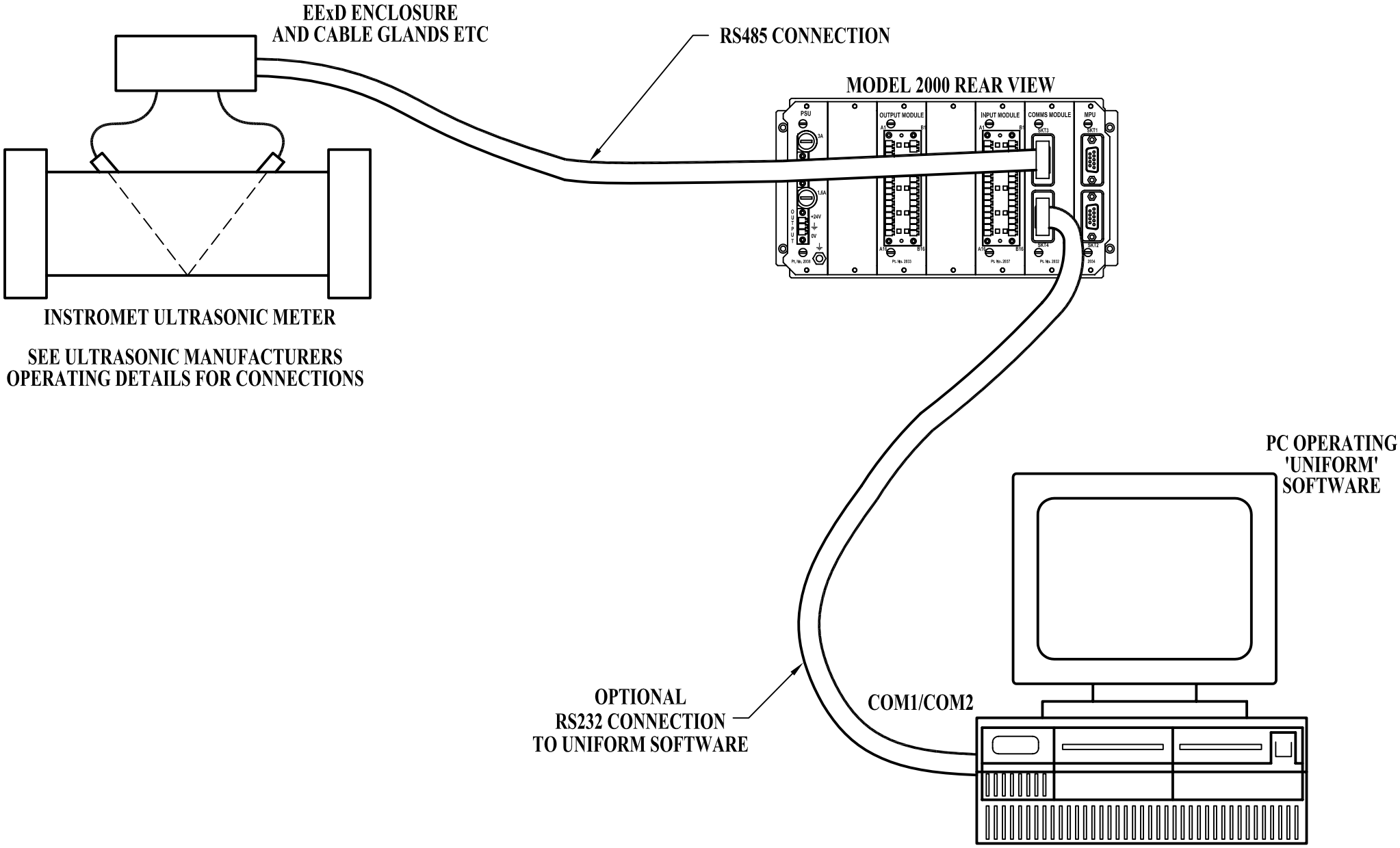
NETWORK 2 BOARD
FIGURE 14



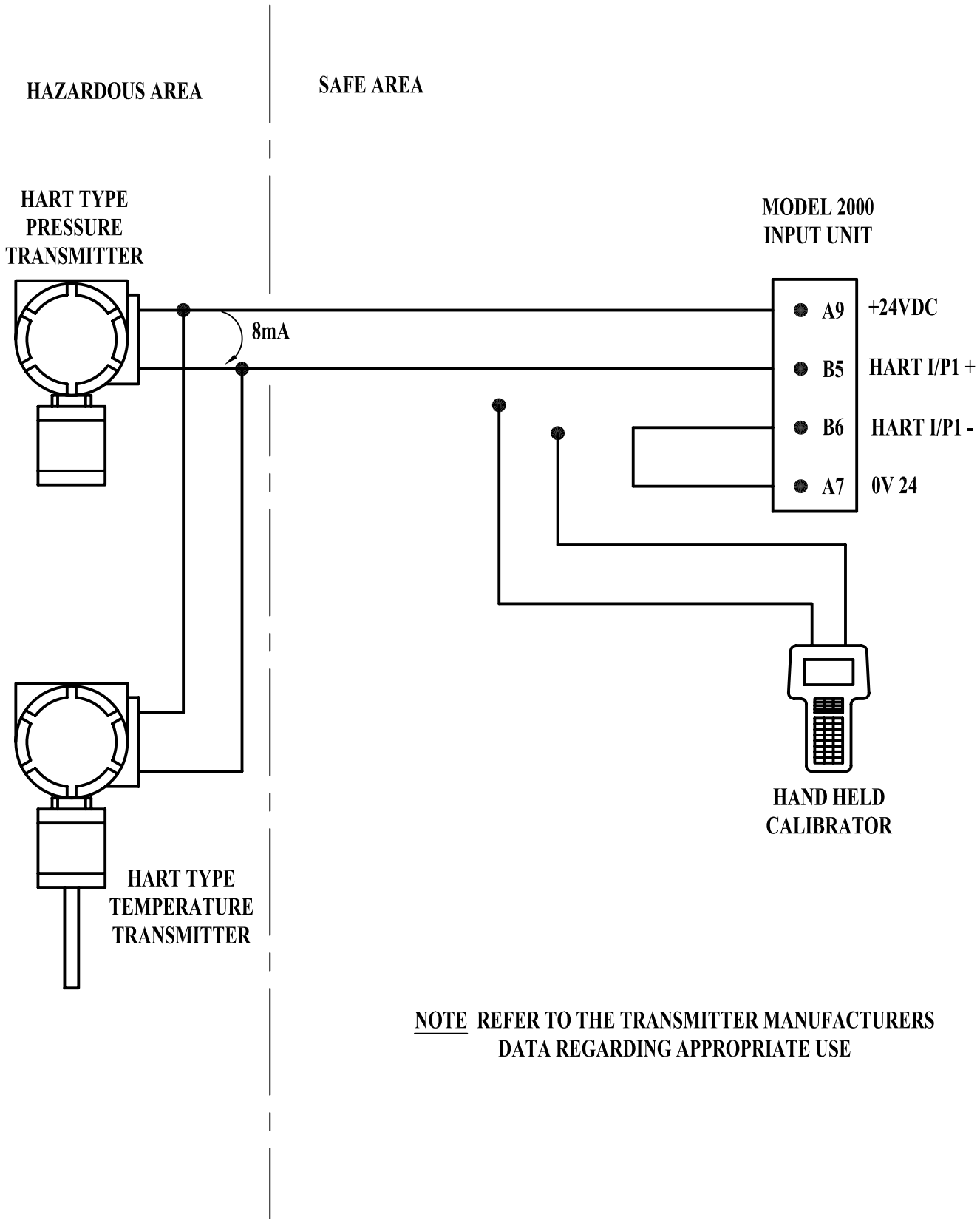
PRT INPUT BOARD
FIGURE 15



MODE SWITCH ACCESS HOLE & BRACKET FIXING POSITION DETAILS
FIGURE 16



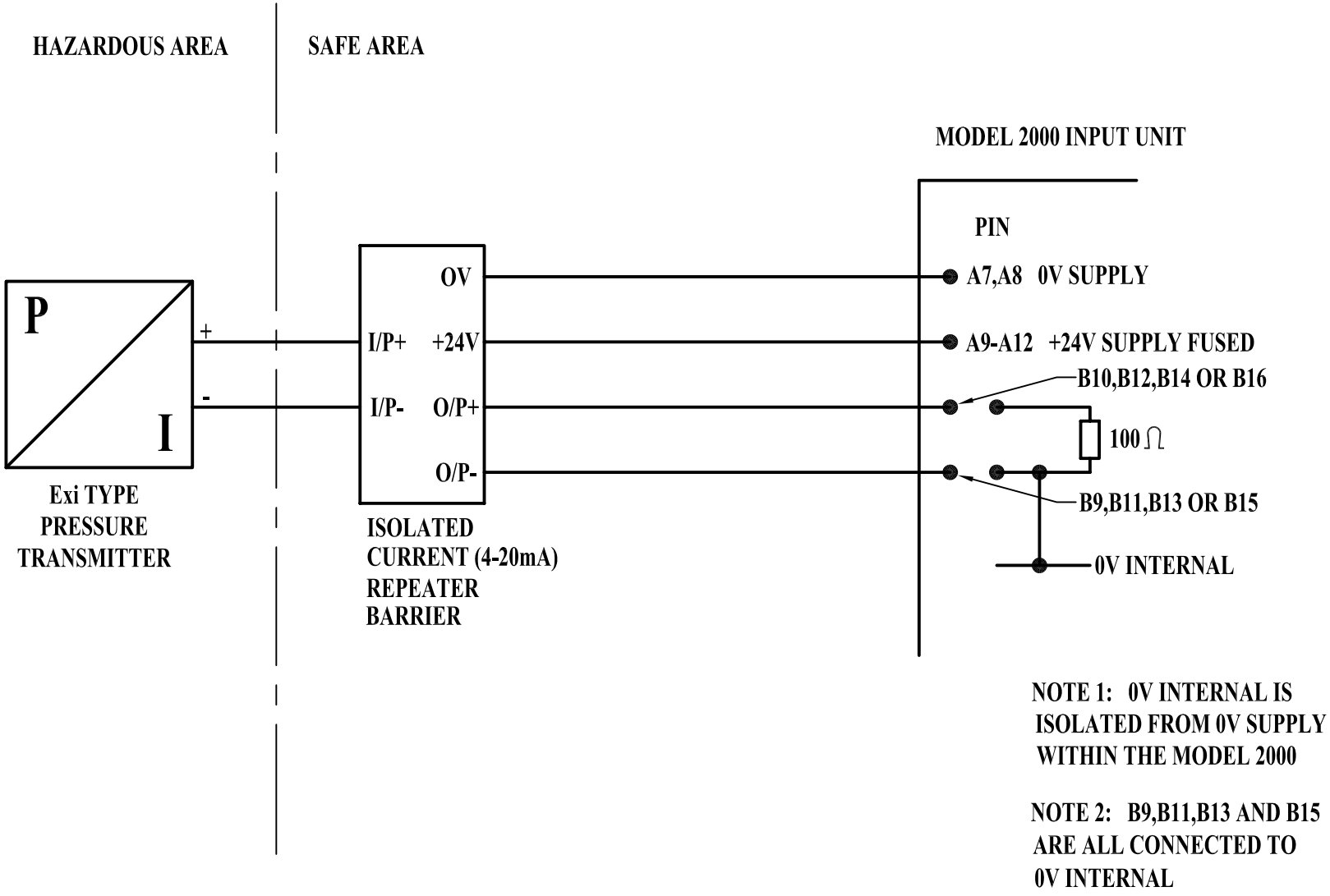
TYPICAL INTERCONNECTION MODEL 2000 - ULTRASONIC METER
FIGURE 17



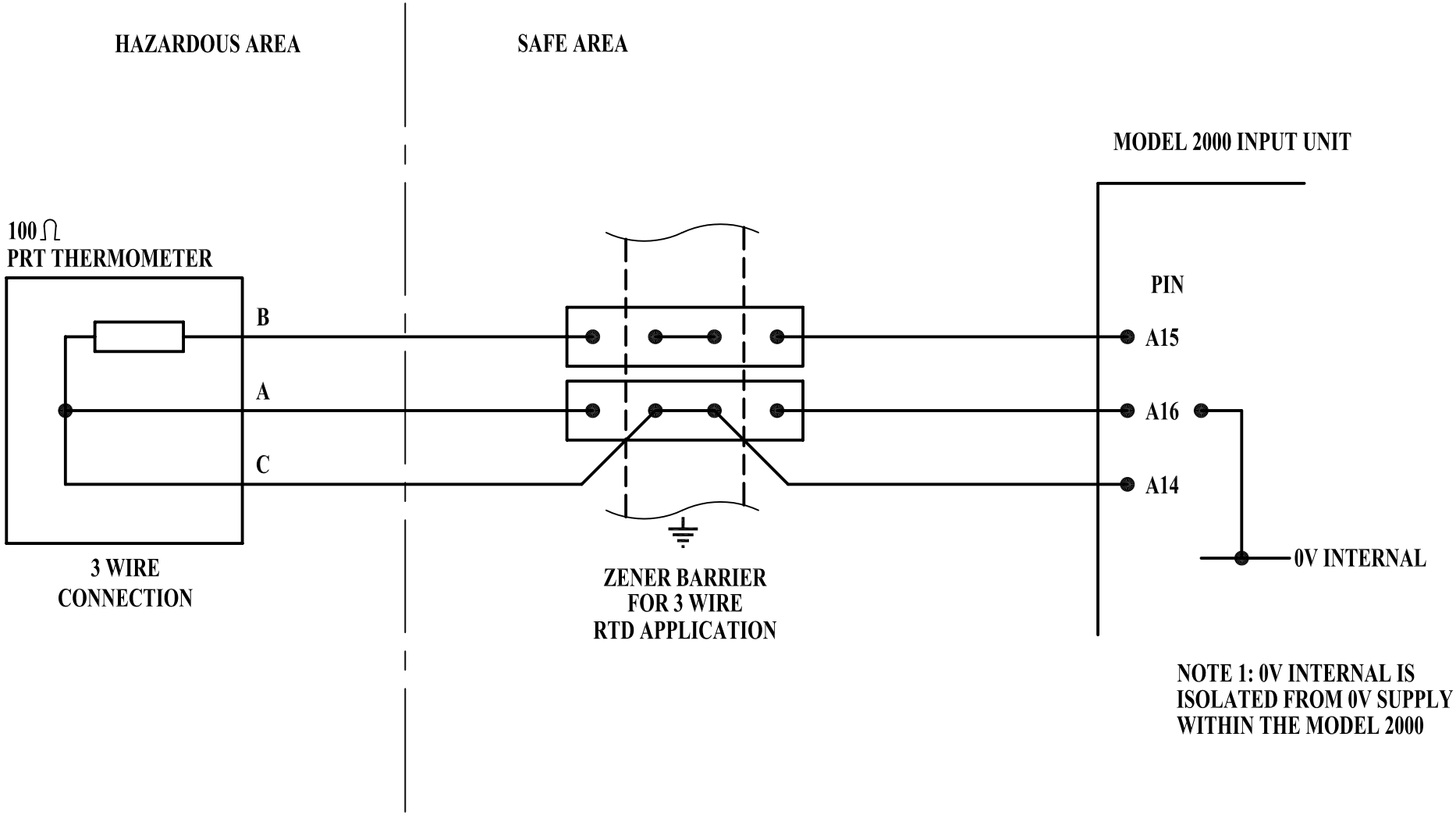
NOTE REFER TO THE TRANSMITTER MANUFACTURERS DATA REGARDING APPROPRIATE USE

TYPICAL SMART (HART) TRANSMITTER CONNECTIONS WHEN USED IN A CONFIGURATION WITHOUT SAFETY BARRIERS

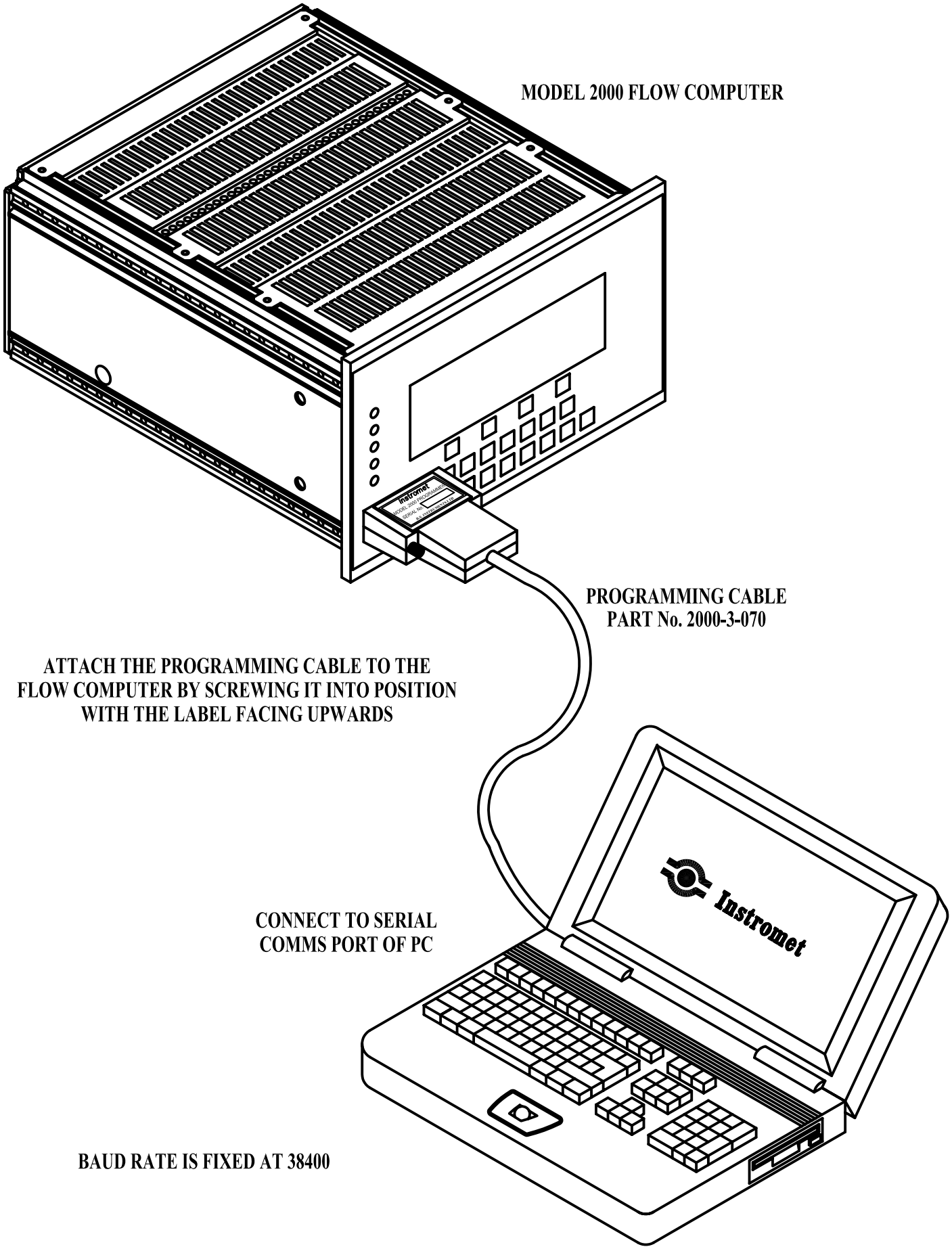
FIGURE 18



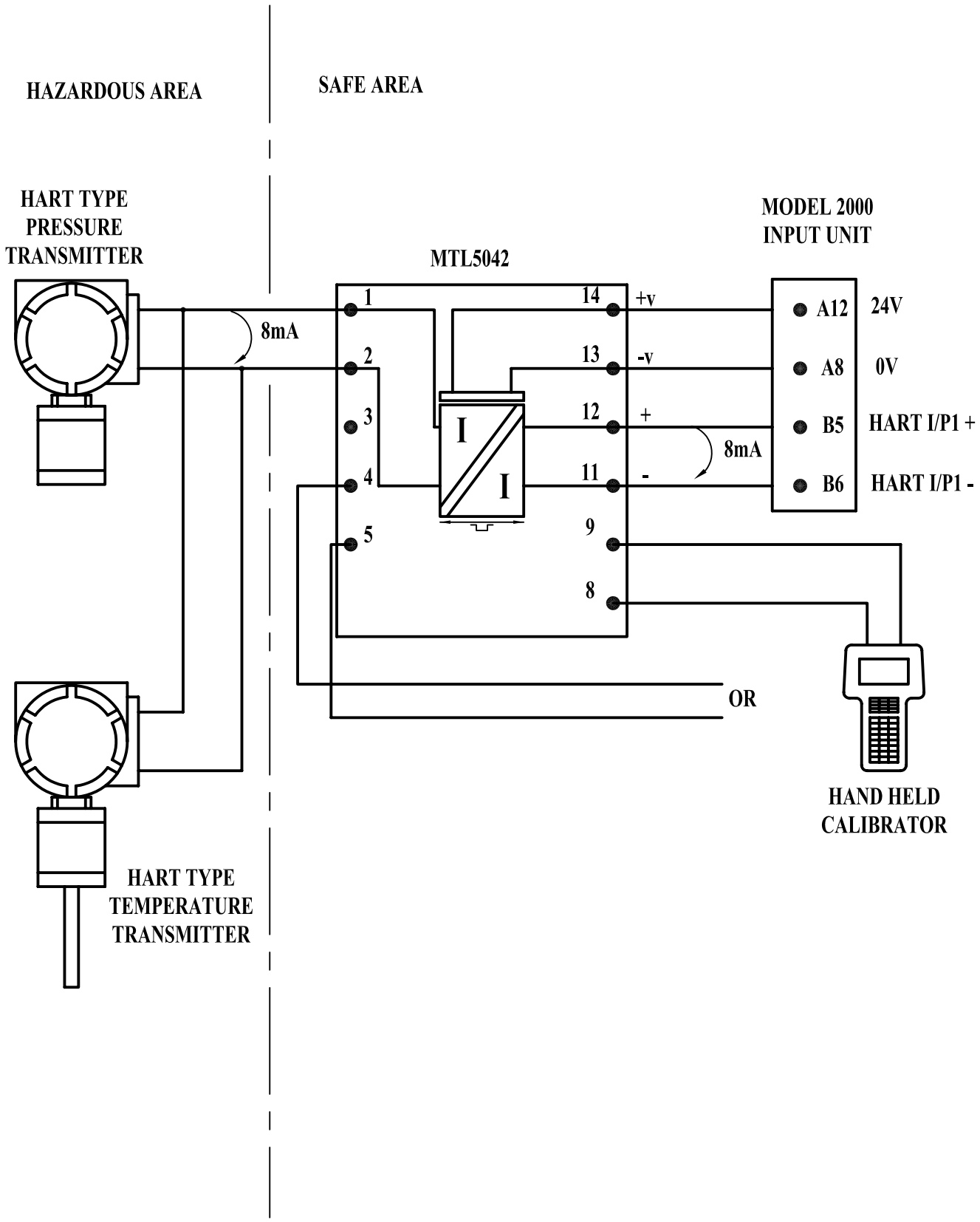
TYPICAL CONNECTION OF A PRESSURE TRANSMITTER (4-20mA)
TO MODEL 2000 FLOW COMPUTER
FIGURE 19



TYPICAL CONNECTION OF A 3 WIRE 100Ω PRT THERMOMETER TO MODEL 2000 FLOW COMPUTER
FIGURE 20

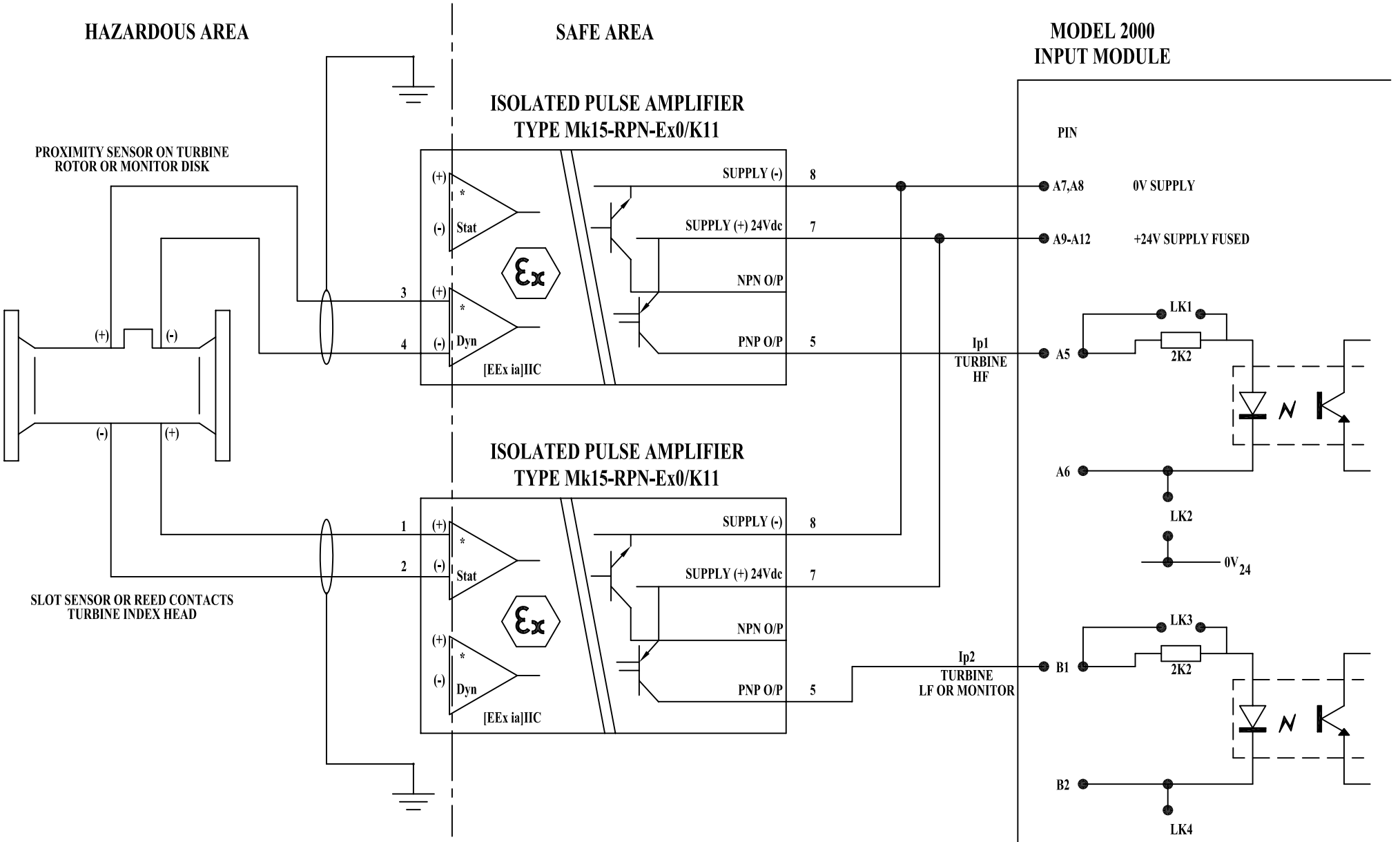


INSTRUCTIONS FOR USE OF MODEL 2000
PROGRAMMING CABLE
FIGURE 21



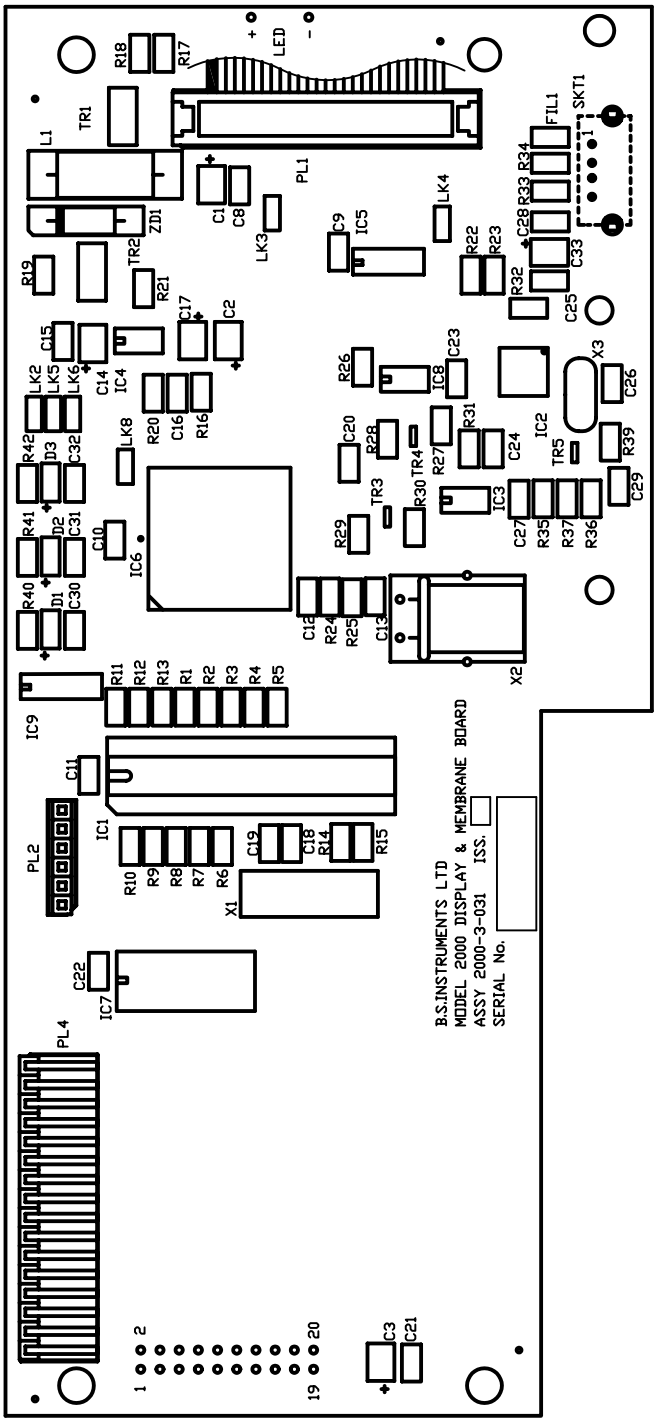
TYPICAL SMART (HART) TRANSMITTER CONNECTIONS

FIGURE 22

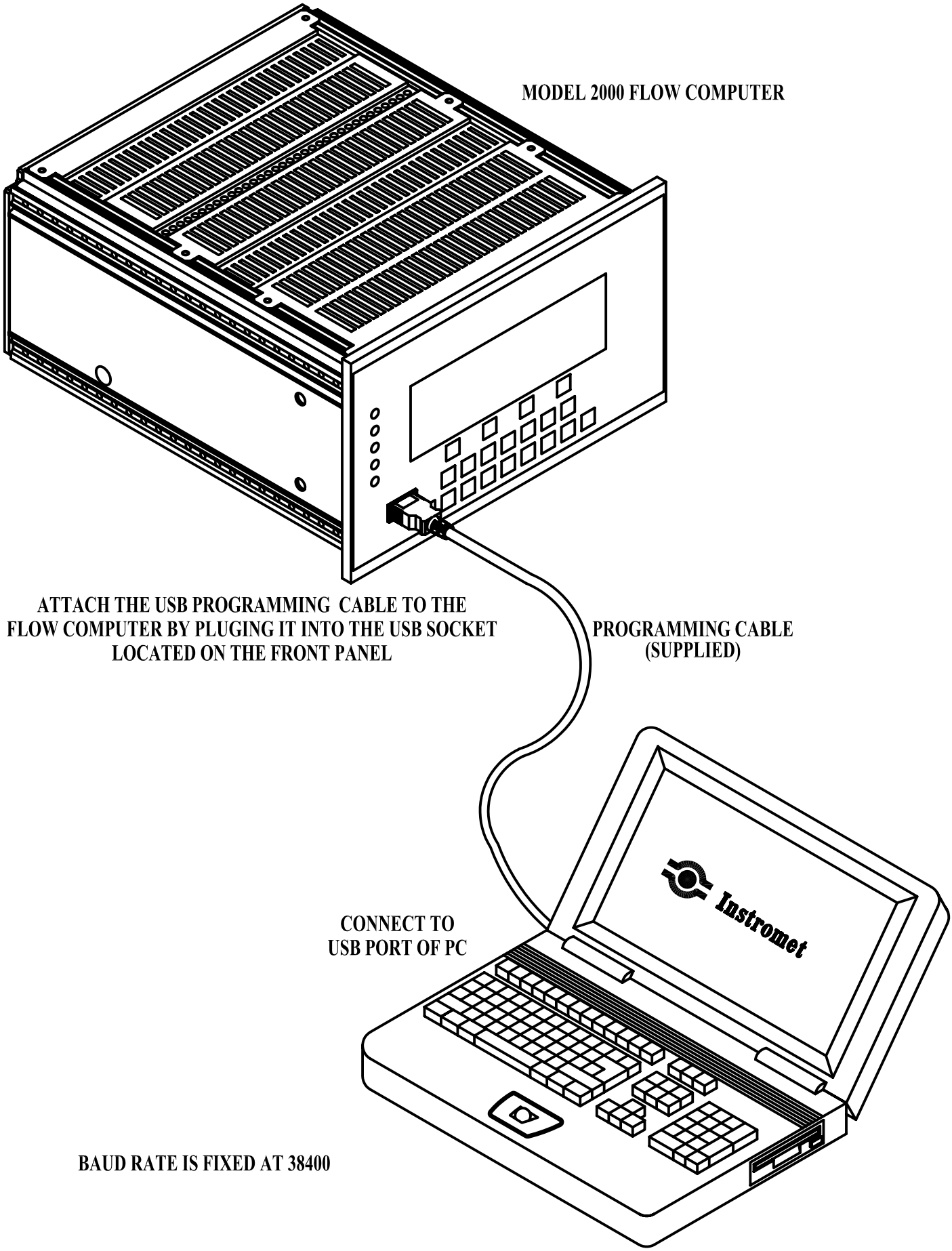


TYPICAL TURBINE METER CONNECTIONS
FIGURE 23

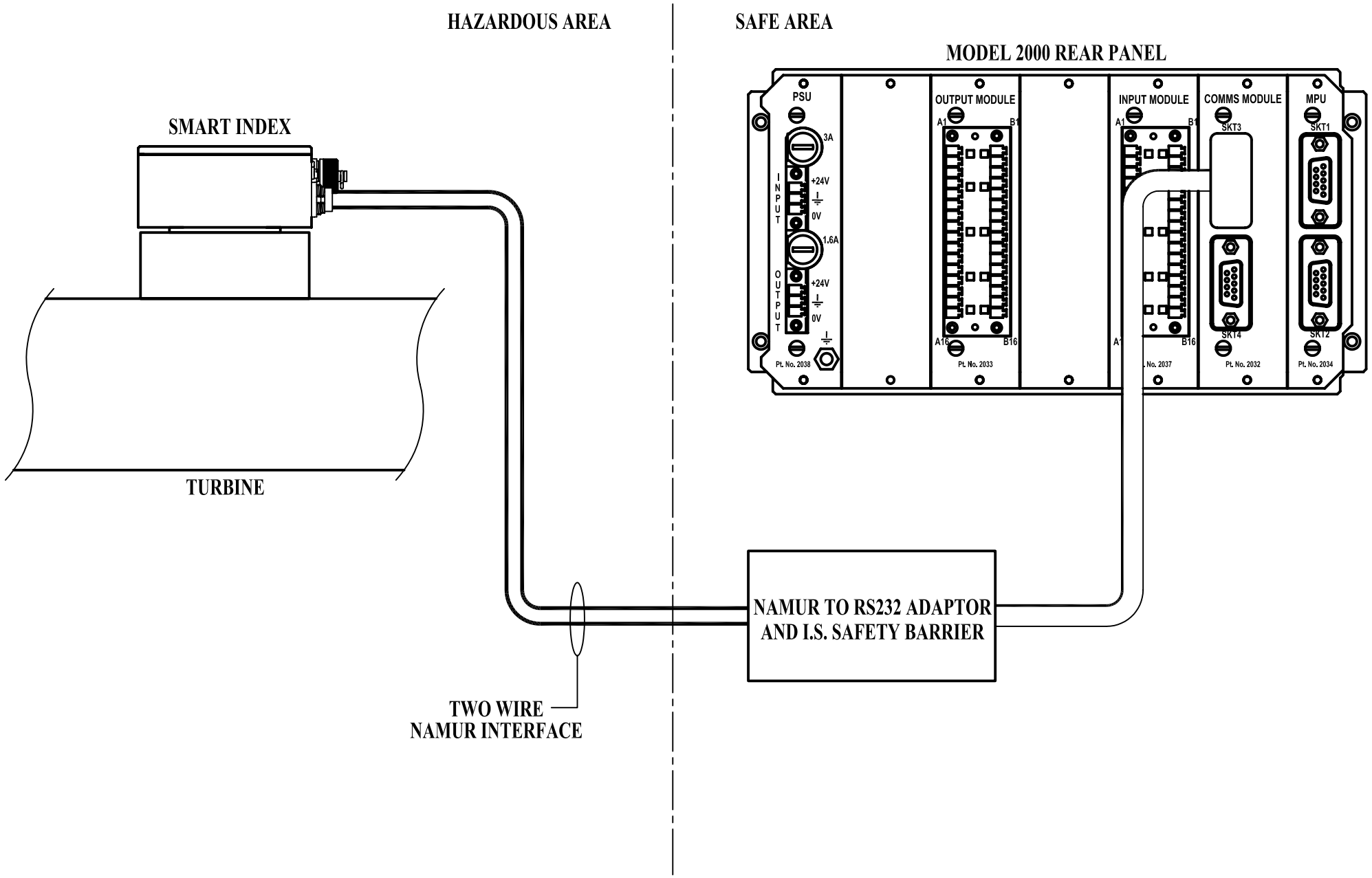
FOR +24V INPUT OPERATION Lk1 & Lk3 ARE OMMITTED
LINK 2 AND 4 CAN BE FITTED OR A6 & B2 CAN BE
EXTERNALLY CONNECTED TO $0V_{24}$



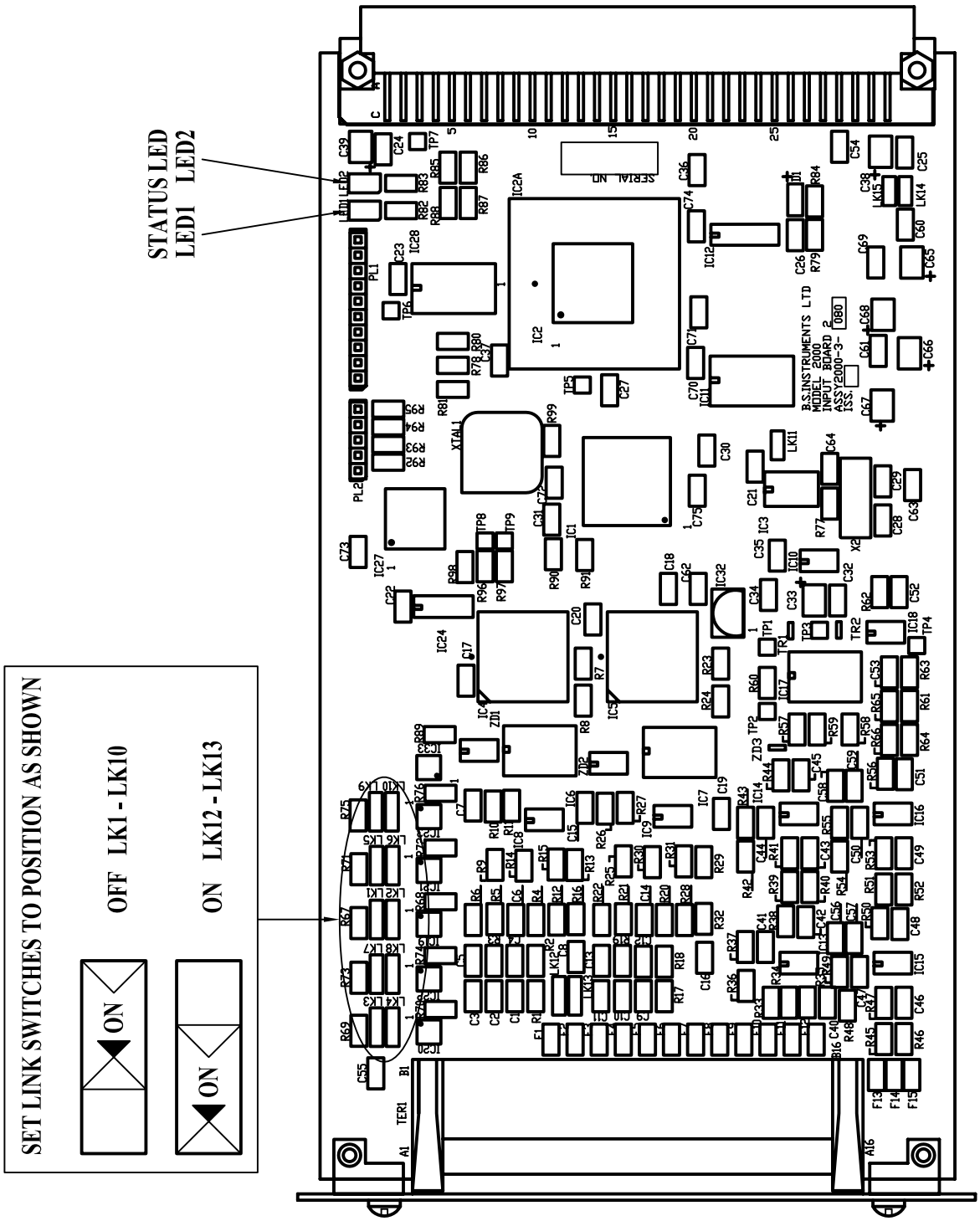
DISPLAY BOARD
FIGURE 24



TYPICAL USB PROGRAMMING CONNECTION
FIGURE 25



SMART INDEX CONNECTION
FIGURE 26



INPUT 2 BOARD
FIGURE 27