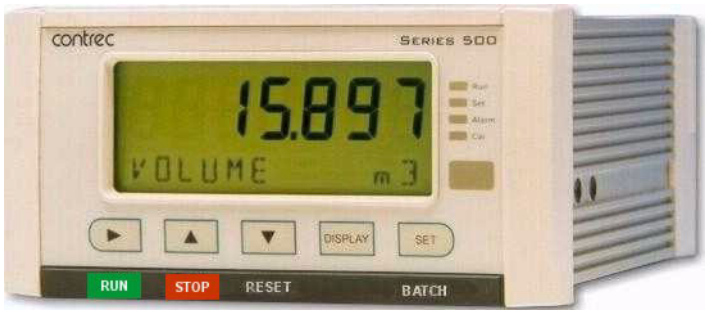
Model 505 Flow Computer

Operation Manual

Application BC04

Dual Stage Batch Controller
for
Mass Analog Flowmeters



7 December 2010

Model 505 Flow Computer - Operation Manual

The instructions given herein cover the general description, installation, operation and maintenance of the subject equipment. Contrec Pty. Ltd. reserves the right, without prior notice, to make engineering refinements that may not be reflected in this manual.

Should any questions arise which cannot be answered specifically by this manual, they should be directed to Contrec Pty Ltd for further detailed information and technical assistance.

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Safety Notice

The information in this safety notice is for the prevention of injury to personnel and damage to the instrument.

The manufacturer assumes no liability for injury or damage caused by misuse of the instrument or for modifications made to the instrument.

Qualified Personnel

The instrument must be installed, operated and serviced by persons who have been properly trained and authorised. Personnel must read and understand this manual prior to installation and operation of the instrument.

Static Hazard

The 500 series flow computer uses high speed CMOS circuitry which is sensitive to static damage. The user should observe accepted safety practices for handling electronic devices, especially during servicing. Once the unit is installed, grounded and interconnected, the chances of static damage are greatly reduced.

Voltage Hazard

Before connecting power to the instrument, ensure that the supply voltage for the AC or DC input is suitable. The AC voltage rating is as stated on the serial number plate. Personnel should take all due care to avoid electric shock.

Welding Hazard

Do not perform electric welding in close proximity to the instrument or its interconnecting cables. If welding in these areas must be performed, disconnect all cables from the instrument. Failure to do so may result in damage to the unit.

Moisture Hazard

To avoid electrical faults and corrosion of the instrument, do not allow moisture to remain in contact with the instrument.

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Chapter 1
Introduction

Features

- Tailored for mass analog flow input
- Single or Dual stage control
- Quick access to common batch quantities
- No-flow, leakage and overflow error detection
- Remote RUN/STOP/RESET
- Allows for square law and non-linear correction
- Storage of 100 transactions with time and date stamp
- Selection of second language and user tags
- Infra-red communications port on front panel
- Pulse width and scaling of pulse output
- 4-20mA retransmission
- Selectable protocols on serial ports including Modbus RTU and Printer output
- Front panel adjustment of 8-24V DC output voltage
- Backlit display with LCD backup

Overview

The 505 BC04 application is a dual stage batch controller for reliable measurement of preset quantities using a mass analog input. Used as a single or dual stage contoller it is suitable for fast batch applications.

It provides the operator with clear local readout and can be controlled via communications in more automated systems. There is quick access to commonly used preset values directly from the front panel if access has been authorized. Automatic overrun compensation caters for system delays such as valve closure for precise volumes.

The analog input can be scaled as well as having filtering, square law or non-linear correction and cutoff points applied to the signal.

Calculations

To derive the flow rate, the analog input is normalised to a value (A) between 0 and 1.

$massflow = (M_f max - M_f min)A + M_f min$

$$mass = \int (massflow \cdot \Delta t)$$

Automatic overrun compensation calculates the new valve closure point to ensure correct delivery by averaging the overrun amount from the last three complete batches.

The overrun compensation value is valid for a new preset value provided the stored overrun is less than 20% of the new preset.

Analog Input Scaling

The analog inputs in this instrument are scaled by the following general formula:

$$f(A) = P_{min} + (P_{max} - P_{min}) \cdot A^*$$

where:

P_{min} = minimum point (equivalent to offset)

P_{max} = maximum point ($P_{max} - P_{min}$ is equivalent to span)

A^* = normalised signal (0 to 1) with correction applied for a flow input

Correction Type

- LINEAR: $A^* = A$ when the instrument is not required to apply correction
- NON-LINEAR: $A^* = A_C$ when the instrument applies correction from the points in the correction table
- SQUARE: $A^* = \sqrt{A}$ when the transmitter does not have square root extraction and it must be applied by the instrument.

Displayed Information

The front panel display shows the current values of the input variables and the results of the calculations.

The instrument can be supplied with a real-time clock for storage of up to 100 transactions with time and date stamps.

Main Menu Variables

Main Menu Variables	Default Units	Variable Type
Mass	kg	Total
Mass Flowrate	kg/min	Rate

Refer to **Available Units of Measurement** on page 62 for the list of available units.

Communications

There are three communication ports available as follows:

- RS-232 port
- RS-485 port
- Infra-red port (optional)

The ports are available for remote data reading, printouts and for initial application loading of the instrument.

Retransmission & Control Outputs

The instrument can retransmit any main menu variable. The digital outputs can retransmit totals as pulses or operate as logic levels for control or error outputs. If the instrument has the advanced option, it outputs rates as a 4-20mA signal.

Relay Outputs

The relay outputs 1 and 2 are used to control the flow of product for each delivery. These contacts are normally open and can be used to drive external relays, valves, pump circuits etc.

Software Configuration

The instrument can be further tailored to suit specific application needs including units of measurement, custom tags, second language or access levels. A distributor can configure these requirements before delivery.

Instrument parameters including units of measurement can be programmed in the field, according to the user access levels assigned to parameters by the distributor.

All set-up parameters, totals and logged data are stored in non-volatile memory with at least 30 years retention.

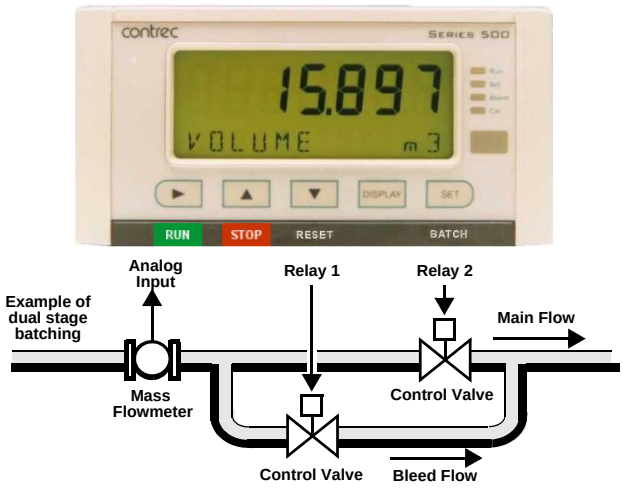


Figure 1 Typical Application Diagram

Approvals

This instrument conforms to the EMC-Directive of the Council of European Communities 89/336/EEC and the following standards:

- Generic Emission Standard EN 50081-1 Residential, Commercial & Light Industry Environment.
- Generic Emission Standard EN 50081-2 Industrial Environment.
- Generic Immunity Standard EN 50082-1 Residential, Commercial & Light Industry Environment.
- Generic Immunity Standard EN 50082-2 Industrial Environment.

In order to comply with these standards, the wiring instructions in **Chapter 3 - Installation** must be followed.

Chapter 2
Specifications

Specification Table

Operating Environment

Temperature	0°C to +60°C (conformal coating) +5°C to +40°C (no coating)
Humidity	0 to 95% non condensing (conformal coating) 5% to 85% non condensing (no coating)
Power Supply	95...135 V AC or 190...260 V AC or 12...28 V DC
Consumption	6W (typical)
Protection	Sealed to IP65 (Nema 4X) when panel mounted
Dimensions	147mm (5.8") width 74mm (2.9") height 167mm (6.6") depth

Display

Type	LCD with 7-digit numeric display and 11-character alphanumeric display (backlit optional)
Digits	15.5mm (0.6") high
Characters	6mm (0.24") high
LCD Backup	Last data visible for 15min after power down (optional)
Update Rate	0.3 second

Non-volatile Memory

Retention	> 30 years
Data Stored	Setup, Totals and Logs

Approvals

Interference	CE compliance
Enclosure	ATEX, FM, CSA and SAA approved enclosures available for hazardous areas

Real Time Clock (Optional)

Battery Type	3 volts Lithium button cell (CR2032)
Battery Life	5 years (typical)

4-20mA Input

Overcurrent	100mA absolute maximum rating
Impedance	250 Ohms (to common signal ground)
Accuracy	0.1% typical full scale (20°C) 0.2% (full temperature range)
Non-linearity	Up to 20 correction points (flow inputs)

Remote Logic Inputs

Signal Type	Voltage free contact, open collector

Relay Output

No. of Outputs	2 relays
Voltage	250 volts AC, 30 volts DC maximum
Current	3A maximum

Communication Ports

Ports	RS-232 port RS-485 port Infra-red port (optional)
Baud Rate	2400 to 19200 baud
Parity	Odd, even or none
Stop Bits	1 or 2
Data Bits	8
Protocols	Modbus RTU, Printer*

Transducer Supply

Voltage	8 to 24 volts DC, programmable
Current	70mA @ 24V, 120mA @ 12V maximum
Protection	Power limited output

Pulse/Digital Output

Signal Type	Open collector, non-isolated
Switching	200mA, 30 volts DC maximum
Saturation	0.8 volts maximum
Pulse Width	Programmable: 10, 20, 50, 100, 200 or 500ms

4-20 mA Output (Optional)	
Supply	24 volts DC internal, non-isolated
Resolution	0.05% full scale
Accuracy	0.05% full scale (20°C) 0.1% (full temperature range, typical)

Important: Specifications are subject to change without notice.
Printer protocol is available only if RTC option is installed.

Chapter 3
Installation

Panel Mounting

The instrument should be located in an area with a clean, dry atmosphere that is also relatively free of shock and vibration.

The standard mounting procedure is panel mounting in a cutout that is 139 mm wide by 67 mm high. Two side clips secure the unit into the panel.

Figure 2 shows the panel mounting requirements for the 500 Series Instrument.

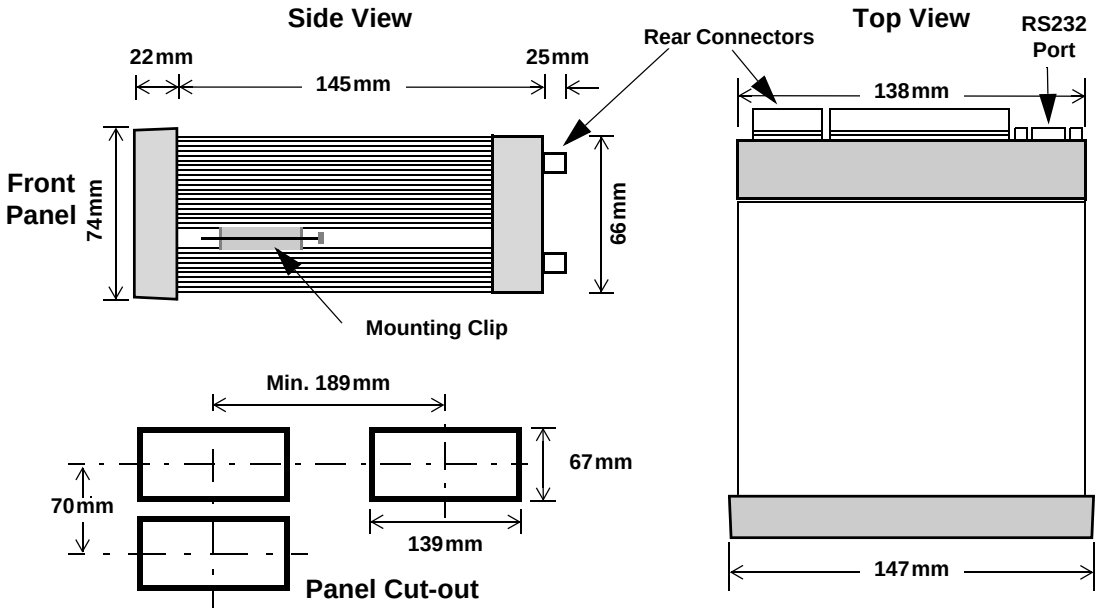


Figure 2 500 Series Instrument Panel Mounting

Electrical Connection

Rear Panel Connections

Figure 3 shows the connections on the rear panel of the instrument.

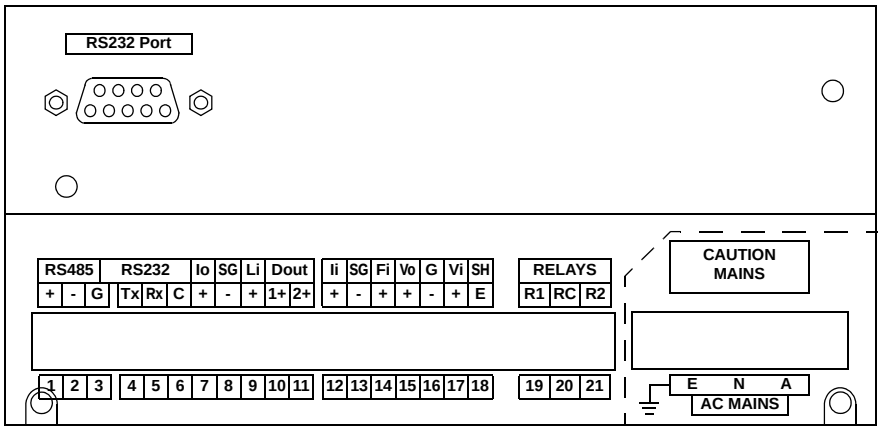


Figure 3 Rear Panel Connections

Terminal Designations

Terminal	Label		Designation	Comment
1	RS485	+	RS485 (+)	
2		-	RS485 (-)	
3		G	Comms ground	
4	RS232	Tx	RS232 data out	Same RS232 port as DB9 connector
5		Rx	RS232 data in	
6		C	CTS (Clear to send)	
7	Io	+	4-20mA output	Advanced option
8	SG	-	Signal Ground 0V	
9	Li	+	Logic input	Remote run
10	D OUT	1+	Open collector o/p 1	Digital outputs
11		2+	Open collector o/p 2	
12	Ii	+	4-20mA input	Mass flow
13	SG	-	Signal Ground 0V	
14	Fi	+	Signal input	Remote stop/reset
15	Vo	+	8-24 volts DC output	70mA power limited
16	G	-	DC Ground	
17	Vi	+	DC power input	DC power in 12-28V
18	SH	E	Shield terminal	
19	RELAYS	R1	Relay 1	Single stage
20		RC	Relay Common	
21		R2	Relay 2	Dual stage
E	AC MAINS	E	Mains ground	AC power in 95-135V or 190-260V
N		N	Mains neutral	
A		A	Mains active	
RS232 port			9-pin serial port	

Inputs

Analog Input Connections

The analog input (Ii) can accept current signals from 4 to 20 mA.

CAUTION

Applying levels of input current above the absolute maximum rating (100mA) may cause permanent damage to the input circuitry.

4-20 mA Inputs

For externally powered current loops, connect each transmitter to a pair of input terminals as shown in Figure 4. Refer to **Terminal Designations** on page 8 for specific terminal numbers for this application.

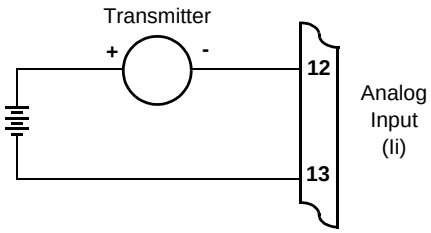


Figure 4 Externally Powered Current Loop

The internal overload-protected power supply has sufficient power for three current loops at 24 V DC (more current loops can be supplied by using a reduced voltage setting). Connect internally powered current loop as shown in Figure 5.

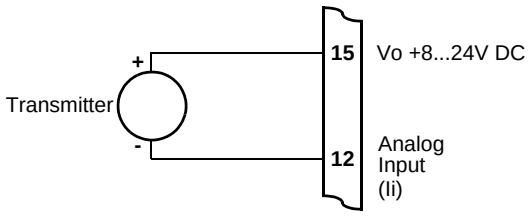


Figure 5 Internally Powered Current Loop

Logic Input Connection

These input(s) are designed to be connected to open collector signals or a voltage free contact switch. A minimum activation time of 300ms is required to guarantee reading of an input.

Remote Run Input

A remote push-button key can be connected to the Logic Input (Li, terminal 9) as shown below.

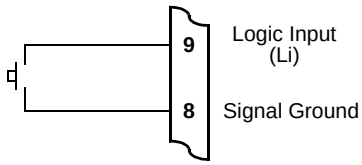


Figure 6 Logic Input Connection Diagram

Remote Stop/Reset Input

A remote push-button key can be connected to the multipurpose Signal Input (Fi, terminal 14) as shown below. A momentary press of the remote key is recognised as a Stop signal, while a press and hold for 2 seconds is recognised as a Reset.

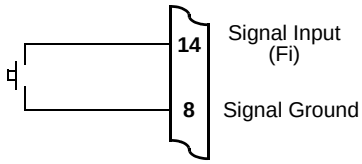


Figure 7 Signal Input Connection Diagram

Outputs

The basic instrument has two digital outputs. The advanced option also provides a 4-20 mA output port.

4-20 mA Output Connection

Figure 8 shows the connections for a 4-20 mA output.

Maximum Load Resistance = 900 ohms

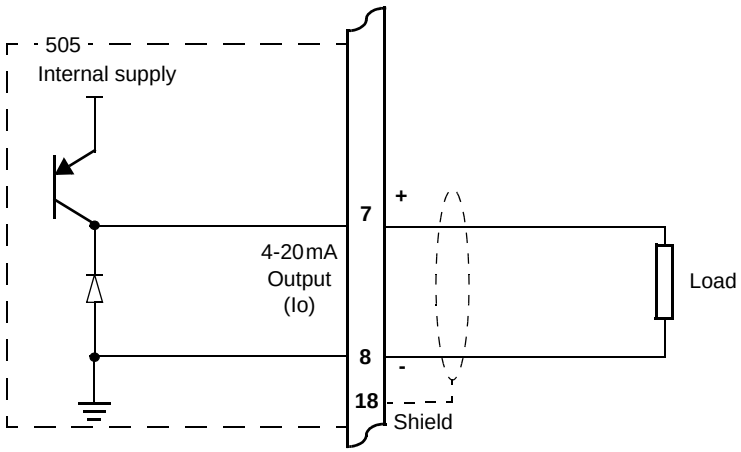


Figure 8 Output 4-20mA Connection Diagram

Digital Output Connection

The digital outputs can be programmed in calibration to function as either a flow error signal, end of batch signal, pump control output or a pulse output for retransmission of totals.

Figure 9 shows a connection example for a pulse output. Output channel 1 uses terminals 10 (+) and 8 (-). Output channel 2 uses terminals 11 (+) and 8 (-).

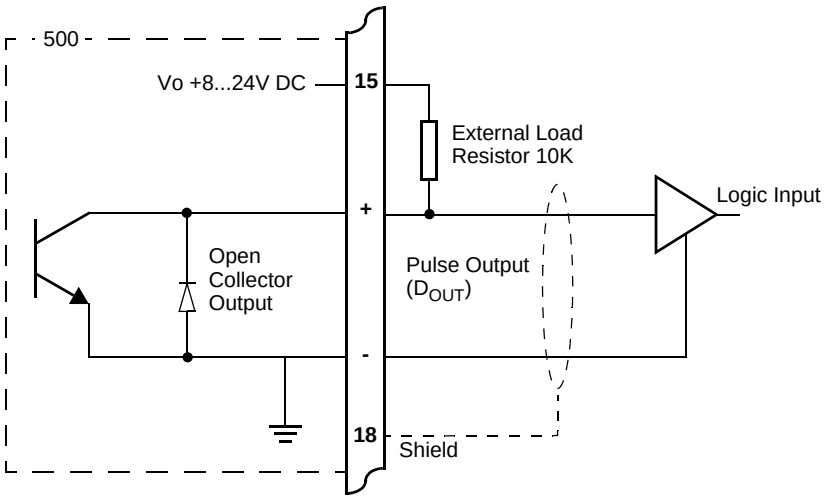


Figure 9 Output Pulse Connection Diagram

Control Relays

The standard instrument has two relays, which are used for the dual stage batch control. The relays can drive external devices such as valves, pump circuits or external relays.

The output characteristics of the relays are:

Maximum Voltage	30 volts DC or 250 volts AC
Maximum Current	3 A

Note: Solid state relays use AC voltage only.

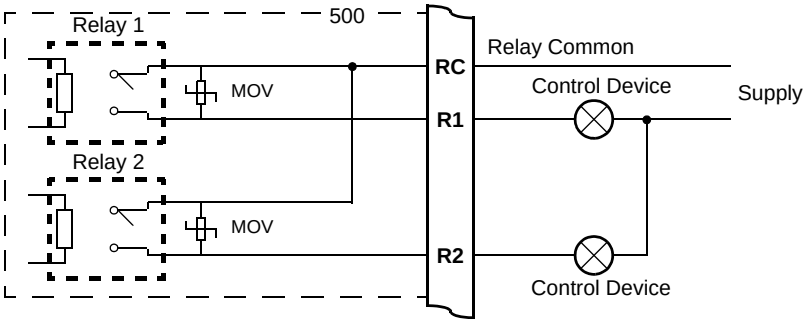


Figure 10 Relay Connection Diagram

RC Network for Interference Suppression

When driving highly inductive loads with the relay outputs, it is recommended to use RC suppression networks (often called “Snubbers”) for the following reasons:

- To limit the amount of electrical noise caused by arcing across the contacts, which may, in extreme cases, cause the microprocessor to act erratically.
- To protect the relay contacts against premature wear through pitting.

RC suppression networks consist of a capacitor and series resistor and are commonly available in the electrical industry. The values of R and C are dependent entirely on the load. However, if the user is unsure of the type of snubber to use, values of 0.25 µF and 100 Ω will usually suffice. Note that only mains-approved RC suppression networks should be used.

The basic principle of the operation is that the capacitor prevents a series of sparks arcing across the contact as the contact breaks. The series resistor limits the current through the contact when the contact first makes.

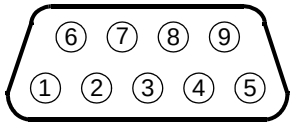
Communications

The communication protocols are described in **Communications** on page 45.

RS-232 Port

The standard RS-232 port uses terminals 4, 5 and 6 on the rear panel.

The extra RS-232 port 9-pin DB female connector has the following pinout:



Pin 1	Not used
Pin 2	Transmit (TxD)
Pin 3	Receive (RxD)
Pin 4	Not used
Pin 5	Ground
Pin 6	Not used
Pin 7	Handshake line (CTS)
Pin 8	RTS Out
Pin 9	Not used

Note: The instrument does not require a null-modem cable for connection to a personal computer. Refer to **Hardware Interconnection** on page 45 for cable termination requirements.

Infra-red Port (Optional)

The infra-red port is located at the front panel, directly below the row of status indicators. The main function of this port is for retrieving current or logged data with a PC that has an infra-red port.

RS-485 Port

Up to 32 units can be connected to a common RS-485 bus. Each unit has a unique address that the host computer uses to identify each instrument.

Figure 11 shows the connection of several instruments to a computer using the RS-485 port.

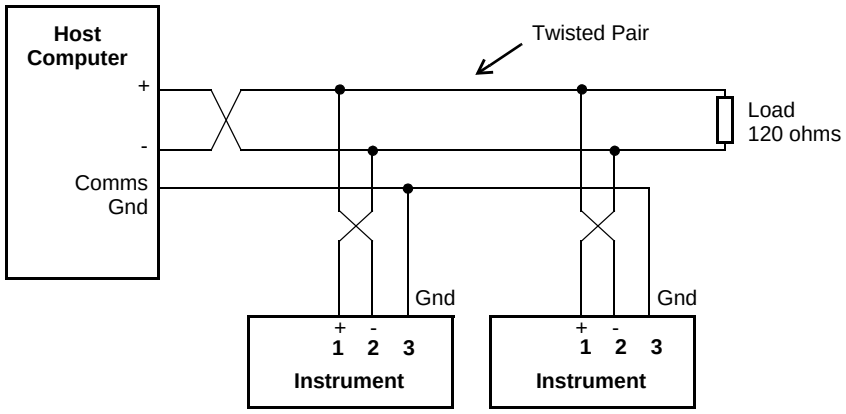


Figure 11 RS-485 Interface Connections

Earthing and Shielding

It is a good practice to use shielded cable for all signal connections to the instrument. Care must be taken to separate signal cables from power cables to minimize interference.

Overall earth should be connected at the instrument end only. This connection should be as short as possible and connected to the earthing point on the rear terminal at pin 18.

Chapter 4
Operation

Front Panel Operation

In normal operation, you press the buttons on the front panel to control the operation of the batch controller or to display the values recorded and calculated by the instrument.

There are several categories of information that the instrument can display:

- Totals
- Rates
- Batch preset values
- Instrument settings

For each total, there is an associated rate as follows:

Total	Rate
Mass	Mass Flowrate

Default Variable

In some applications, a particular variable is of more interest than others, and for this reason a default variable can be assigned during instrument calibration. The default variable is used in the following ways:

- Determines what the display returns to if the display timeout option is enabled and no buttons are pressed for the selected period (usually 30 seconds). It also determines what is displayed on power up.

Status Lamps

The status lamps illuminate to show the following conditions:

Run Solid led: The instrument has a batch in progress.
Fast flashing led: Batch paused.
Slow flashing led: Waiting for valves to close.
Set Solid led: The instrument is in Calibrate Set mode.
Flashing led: Count down to automatic restart of next batch.
Alarm The instrument has an error, as indicated on the display panel.
Cal The instrument is in Calibrate View mode.

Front Panel Keys

RUN Press the **RUN** key to start or resume a batch. The run led will illuminate.

STOP Press the **STOP** key to halt a current batch. The instrument will go into pause mode and the run led will flash at a steady pace. The incomplete batch can be resumed. Also used to stop the next batch if in automatic restart count down.

RESET Use the **RESET** key to clear the batch totals or to initiate a printout if the printer option has been selected. The print is activated with a single press while the reset of the totals requires a press and hold for two seconds.

The instrument makes three beeps when it resets the totals and two beeps when a printout is started.

DISPLAY Press the DISPLAY key to step or scroll through the main menu items.

BATCH Hold the **BATCH** key to display the current batch preset value. Continue to hold for two seconds to enter edit mode for the preset if access is authorised. Pressing the **BATCH** key briefly displays the accumulated total.

Main Menu Items

The main menu in this instrument consists of the following items. The DISPLAY key is used to step or scroll through the list. The full menu can only be viewed if the batch controller has been stopped and reset.

DISPLAY ↓	Description	Options
MASS	Mass	Hold the SET key to display (or edit) the batch preset or briefly press to view the accum total
FLOW	Mass flowrate	
REPORT PRINT	Only shown if print option is selected	Hold the SET key to print log report as defined in the TM/LOG section of calibration.
LOGGED DATA	Only shown if real-time clock option is installed	Hold the SET key to display data logs as described in **Data Logs** on page 17.
MODEL INFO		Hold the SET key to display the Model information as described in **Model Information** on page 18.
CAL MENU		Hold the SET key to enter Calibration View mode as described in **Calibration View Mode** on page 23.

Setting the Batch Preset

SET The batch preset can only be set while the instrument is in the non-operational state, i.e. batch is complete or has been stopped and reset. Hold the SET key to display the current preset value while viewing the total variable. The display of the preset will change from view mode to edit mode after 2 seconds if access has been enabled in calibration. Once in edit mode the **Set** indicator will illuminate and the preset value can be changed in the same way as in calibration set mode, see **Changing Numeric Settings** on page 25. The SET key is used to exit edit mode.

Limit on Batch Size

To prevent accidental entry of large batch quantities, a maximum batch limit can be programmed during calibration. The operator is then prevented from entering a batch quantity which exceeds this value.

Common Preset Values

If the batching application continually uses a regular set of preset values then quick access can be provided to these. In calibration, there is the opportunity to enter up to 10 commonly used preset values.

These can then be accessed whilst in batch edit mode (described above) by pressing the DISPLAY key. The pre-programmed values will appear in the order they were entered in calibration. The display will step through the presets back to the currently entered value which can still be manually edited. While displaying the desired preset value, press the SET key to accept the value and exit edit mode.

Data Logs

The instrument will log up to 100 deliveries (batches) if the real-time clock option is installed. The logs are taken at the end of each batch or upon reset if a batch has been aborted before the preset total has been reached. Each entry has a log number, a delivery number and a time and date stamp.

When the number of log entries exceeds 99 the oldest log entry is overwritten by the newest one.

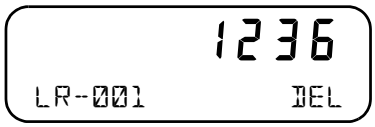
View Data Logs

Use the following procedure to view the data that has been logged by the instrument:

1. Press the DISPLAY key to scroll through the menu to the LOGGED DATA prompt.

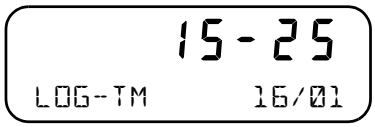
2. Hold the SET key.

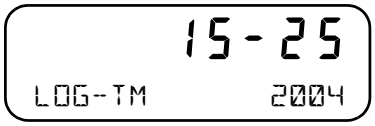
The system displays the most recent log record first. The log record number and corresponding delivery number are shown, for example LR-001 and DEL 1236.



3. Use the ▲ or ▼ keys to scroll to the delivery number or log record of interest.
4. Press the DISPLAY key to show the information stored in the selected log record. Each log record consists of:
   - time and date stamp,
   - error code
   - totals for the delivery.
5. While holding the DISPLAY key use the ▶ key to step through the stored information.
6. While holding the DISPLAY key use the RESET key to print the data for the displayed log if the printer option has been selected.

The following example shows the format of the time and date stamp at 15:25 (3:25 pm) on 16 January 2004. The day and month alternate with the year in the bottom right hand corner.





Model Information

The model information items display the hardware, software and application versions of the instrument. This information is mainly for service personnel.

DISPLAY ↓	Description
-1--F- 505 MODEL	The hardware model code. Refer to **Product Codes** on page 59 for more information.
-F BC04 INPUT	The Application number and the assignment of the inputs. Refer to **Application Information Code** on page 60 for more information.

DISPLAY ↓	Description
0 10 1.002 BC04 VERS	The version of software loaded into the instrument.
026357 CUSTOM VERS	The Customer version code for this installation. Refer to **Custom Version Codes** on page 60 for more information.
123456 ABC123 S/N	The instrument serial number and unit tag. The serial number is on the top line and unit tag is on the bottom left. Both items are entered when the instrument application software is initially loaded. If the unit tag is not used the default tag, UNIT, will be used.
16- 15 EDITED 27/08 2002	The time and date when the calibration of the instrument was last edited. The format of the time and date is the same as for the data logs. This example shows 16:15 (4:15pm) on the 27th August 2002. This function is available only if the instrument has the real time clock option.

Press SET at any time to exit from the Model information.

Batch Operation

Starting a Batch

The delivery (batch) will start when the **RUN** key is pressed. The RUN led will illuminate and the instrument will begin to totalise from zero or, if programmed for count down mode, the display will decrement from the preset quantity.

The batch controller's two relays can be used to control the delivery of product. These are energised and de-energised as described below.

Stopping a Batch

The delivery (batch) can be stopped at any time by pressing the **STOP** key. Once the process has been interrupted in this way it can be continued (if the **STOP** key functionality is programmed to PAUSE) by pressing the **RUN** key or the batch can be aborted and the instrument reset by pressing the **RESET** key.

When the process is in pause mode, the RUN led will flash to prompt the operator to restart or abort the batch.

Resetting a Batch

The instrument can be programmed to reset by different means.

- After the end of a batch, the **RESET** must be pressed to reset the batch total. If the instrument is programmed to count down, the display will revert to the preset value. If it is programmed to count up, the batch total will clear to zero. The next batch can not be started until the previous batch total has been reset.
- If Auto Reset is enabled in the parameters section of calibration, the batch total will automatically reset when the next delivery (batch) is started.

Logic Input Control

This instrument allows for remote operation via the logic inputs on the rear terminals. The logic input have the following functions:

- Logic Input - Remote Run
- Signal Input - Remote Stop/Reset (inhibits remote Run)

For connection details, refer to **Logic Input Connection** on page 9.

Batch Errors

The instrument has the ability to raise an alarm when it detects a loss of flow, an overflow or a leakage in the system.

- **No Flow Error** - The no flow condition is detected when the flow timeout expires during a delivery. There must not be a period of no flow greater than the timeout value during the delivery.
- **Overflow Error** - The overflow condition is detected when the flow continues longer than the timeout period after the controller has attempted to stop the flow.
- **Leakage Error** - The leakage condition is detected when an amount greater than the acceptable total is received without flow being initiated by the batch controller.

The point at which these errors are detected is dependant on the values programmed into the calibration parameters Batch Flow Timeout and Acceptable Total. The open collector outputs can be assigned to activate whenever one of the flow errors occur. Refer to **Instrument Settings** on page 29 for more details.

Batch Control Processes

The batch controller can be programmed to operate in various ways including:

- Manual Reset (manual start).
- Automatic Reset (manual start).
- Automatic Restart for continuous batches.

In each of the above modes and configurations the parameters can be programmed to determine the behaviour and timing of relays and output signals. The following figures provide examples of some batch operations. Refer to **Instrument Settings** on page 29 for more details.

Manual and Automatic Reset

If Manual Reset the **RESET** key must be pressed at the end of the batch to clear the batch total. This must be done before another batch can be started. If Automatic Reset is programmed, a new batch is commenced each time the **RUN** key is pressed.

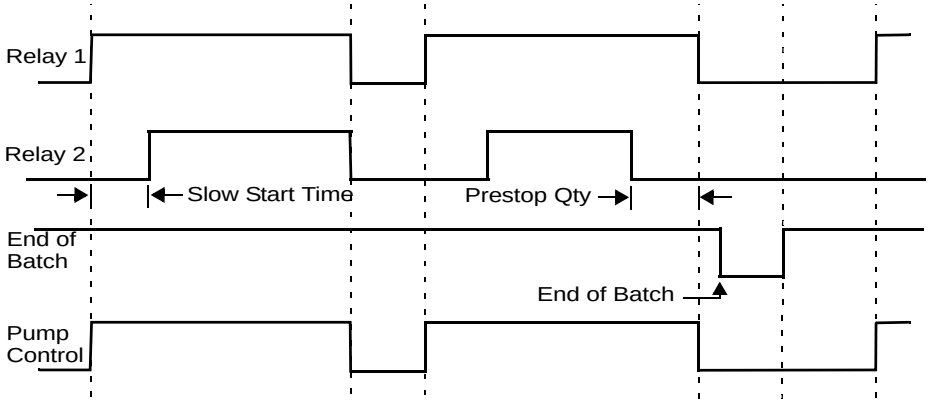


Figure 12 Batch Operation with Manual or Automatic Reset

Automatic Restart

If Automatic Restart is enabled the next batch will commence automatically when the restart timer expires after the end of batch has occurred. The SET led will flash while the instrument is waiting to automatically restart.

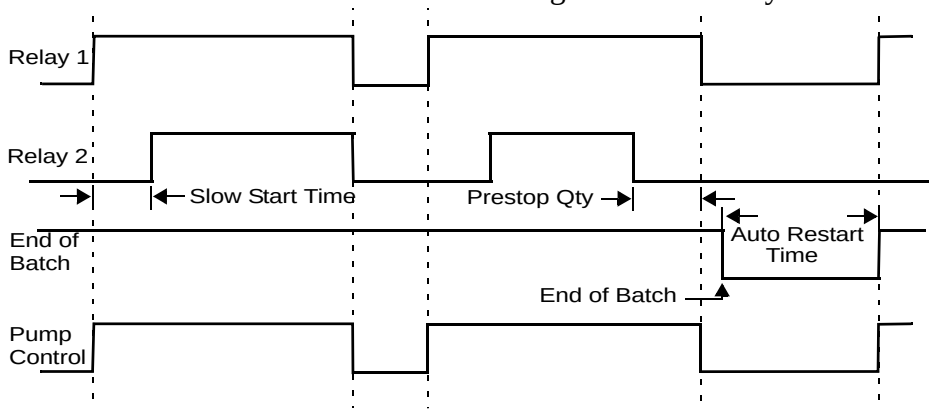


Figure 13 Batch Operation with Automatic Restart

Chapter 5
Instrument Calibration

Introduction

You can view or change the settings of the instrument according to the access level for each parameter as set by the manufacturer. There are four levels of access to the parameters as follows:

- **Not visible** - you cannot display or edit the parameter.
- **Display Only** - you can display the parameter, but you cannot change the setting.
- **Programmable** - you can change the setting of the parameter in Calibration Set mode.
- **Password protected** - you can change the setting of the parameter in Calibration Set mode only if you enter the correct password.

Note: When you enter Calibration Set mode, the instrument requests you to enter a password. Any value will allow to change the settings of the "programmable" parameters, but the correct password must be entered to change the password-protected parameters.

Calibration View Mode

Use the following procedure to view the calibration settings of the instrument:

1. Press DISPLAY to scroll to the CAL MENU prompt.

2. Hold the SET key.

The instrument beeps once, illuminates the **Cal** indicator and shows CAL on the display panel.

- Press ▶ to scroll through the flashing menu headings.
- Press SET to scroll through submenu items.
- Press DISPLAY to return to the main calibration menu.

3. To exit from the Calibration View mode, press ▶ to scroll to the END option and press SET.

The instrument returns to Normal Operation mode.

Calibration Set Mode

In Calibration Set mode, you can change the settings of the “programmable” parameters. You must enter the system password to change the setting of the “password-protected” parameters.

Use the following procedure to enter Calibration Set mode:

1. Press DISPLAY to scroll to the CAL MENU prompt.

2. Hold the SET key.

Run
Set
Alarm
Cal

The instrument beeps once, illuminates the **Cal** indicator and shows CAL on the display panel.

3. Press ▶ to select any flashing menu heading except END.

4. Hold SET for two seconds.

The instrument requests a password.

5. Press ▲ or ▼ to change the value of the current digit. To select the next digit, press ▶.

6. Press SET to accept the password.

- The instrument makes two beeps for a correct password entry and enables you to change the “programmable” and “password-protected” parameters.
- The instrument makes one beep for an incorrect password entry and enables you to change only the “programmable” parameters.

Run
Set
Alarm
Cal

The instrument illuminates both the **Cal** and **Set** indicators.

7. Edit the instrument parameters as required. The programmable values are indicated by the flashing display.

- To change a numerical value, press ▲ to increase a value, or press ▼ to decrease a value. Press a key momentarily to change the value one number at a time. Hold a key to scroll through the numbers. To proceed to next digit, press ▶.
- To change an option setting, press ▲ or ▼ to scroll through the options.

8. Press SET to accept the currently displayed value and proceed to the next parameter. You can press DISPLAY to return to the main calibration menu.

9. To exit from Calibrate Set mode, press ▶ to scroll through the main calibration menu to END, then press SET. Otherwise, from any menu, you can press and hold SET for two seconds.

Run
Set
Alarm
Cal

The instrument makes two beeps and cancels the **Cal** and **Set** indicators.

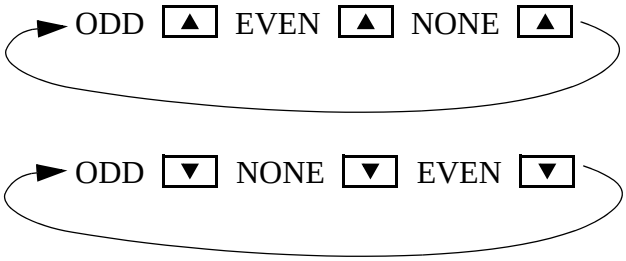
Changing the Instrument Settings

In Calibration Set mode, the display flashes the item that can be changed. For option settings, the display flashes the complete option. For a numeric parameter, the display flashes one digit at a time, you can change the value of the flashing digit as required, then move the flashing cursor to change another digit.

Note: When you change the setting of a parameter, the instrument records the result as soon as you move to another parameter, or exit from the Calibration Set mode.

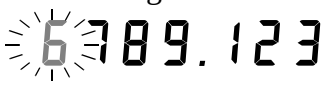
Changing Option Settings

When you display an option that can be changed, the entire option flashes on the display, such as the choices of ODD, EVEN or NONE for the communications parity bit checking. Press ▲ or ▼ to change the option. You can "scroll" through the options in either direction to make a selection as shown below.



Changing Numeric Settings

The display flashes the digit that can be changed.



Press ▶ to select the digit that you wish to change.

Press ▲ or ▼ to increase or decrease the value of the selected digit.

Changing the Decimal Point

To change the position of the decimal point, press ▶ to move the flashing selection until the decimal point flashes. Press ▲ or ▼ to move the decimal point to the right or left as required.

Units of Measurement

The calibration of some parameters is based on the units that are defined for the relevant variables. These units of measurement can been viewed in the UNITS menu in calibration below.

Calibration Menu Tree

Figure 14 and Figure 15 show the keys for moving around the calibration menu tree in Calibration View or Set mode.

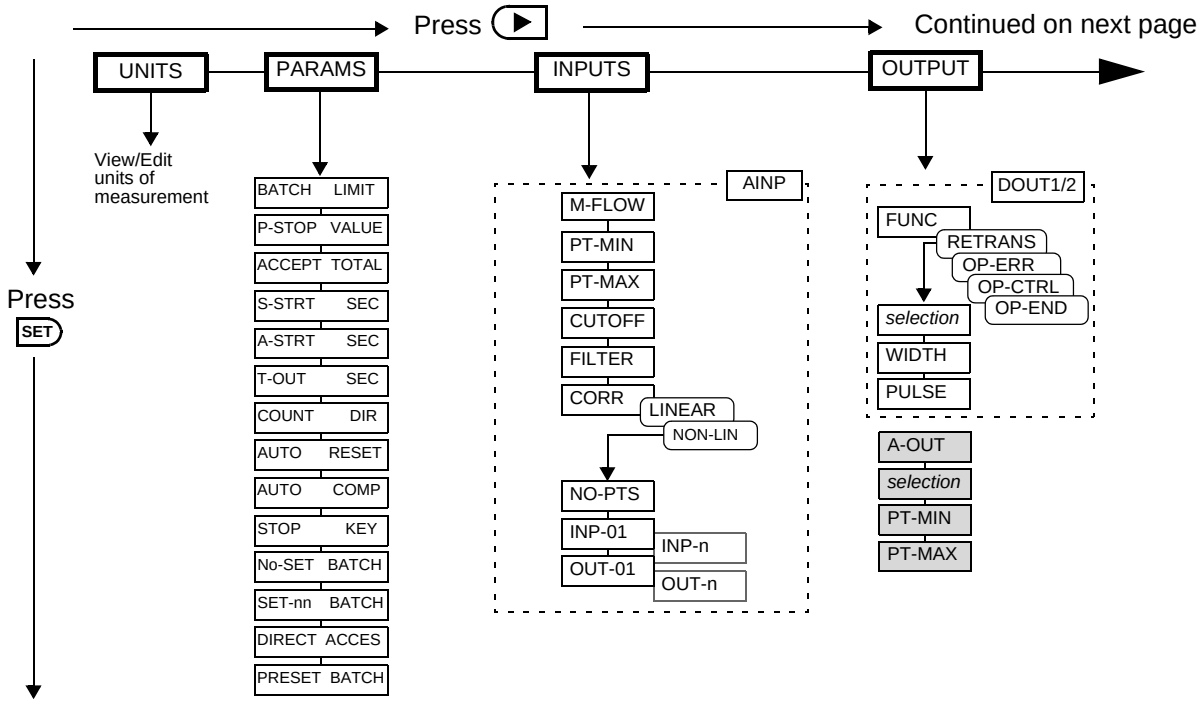
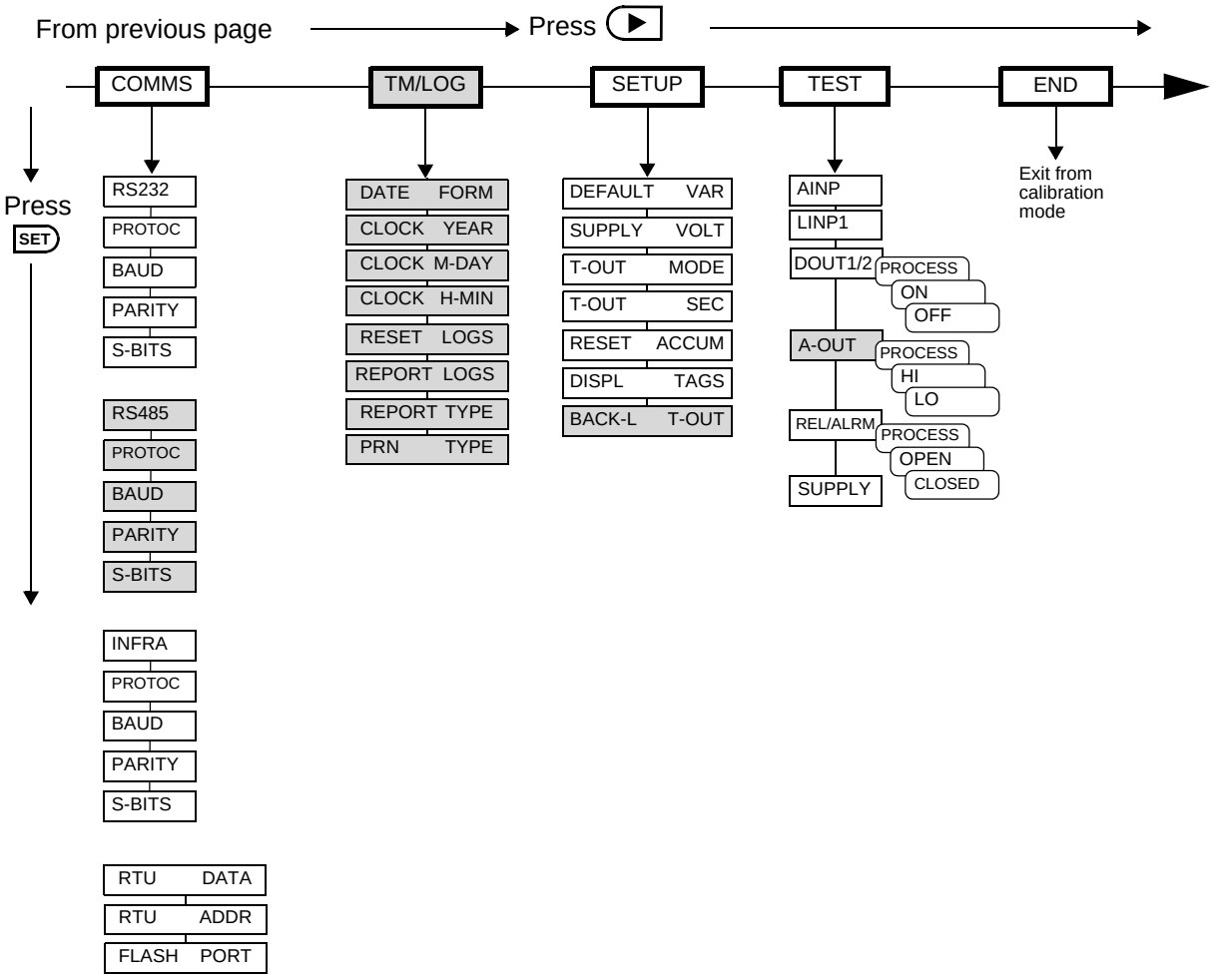


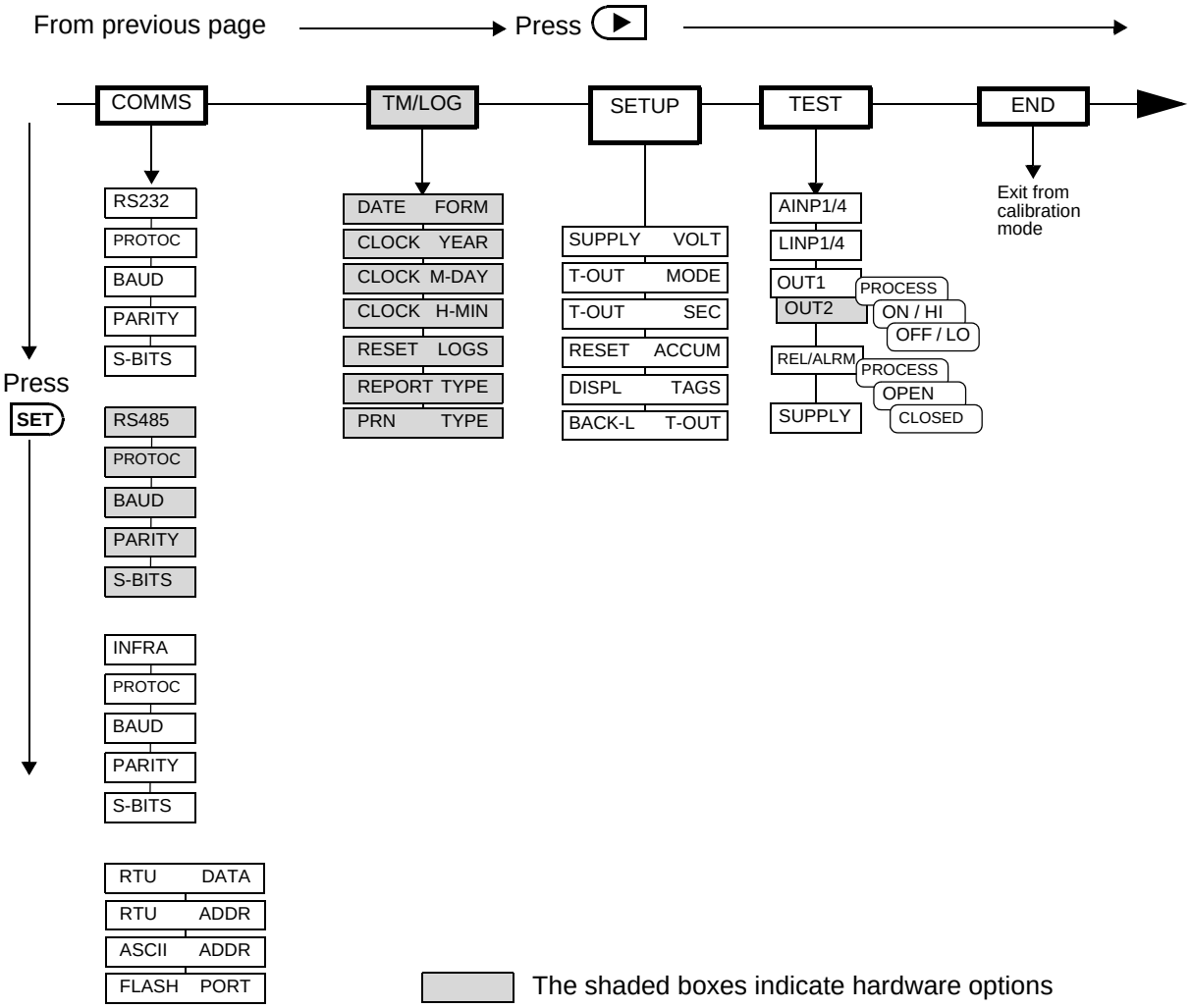
Figure 14 Calibration Menu Tree Sheet 1



The shaded boxes indicate advanced options

Press DISPLAY at any point to return to the main calibration menu.

Press ▶ at any I/O assignment position to move to the next I/O assignment in the submenu (eg pressing ▶ on ALRM1 will move you to ALRM2)



The shaded boxes indicate hardware options

Press DISPLAY at any point to return to the main calibration menu.

Press ▶ at any I/O assignment position to move to the next I/O assignment in the submenu (eg pressing ▶ on ALRM1 will move you to ALRM2 if it exists)

Figure 15 Calibration Menu Tree Sheet 2

Instrument Settings

Units of Measurement

The Units menu allows the units to be viewed and edited if necessary without the reloading of new application software. Any change in units will result in a full reset to initially downloaded settings. Therefore, any required changes to units of measurement should be made before changing any other settings.

SET ↓	▶ → **UNITS** PARAMS INPUTS OUTPUTS COMMS TM/LOG SETUP TEST END
ITEM *n* *unit*	The units for main menu or calibration items can be viewed by pressing the SET key. The units of measurement are password protected. To edit the units the correct password must be entered on entry to EDIT mode. Press ▲ or ▼ to select the required units. Refer to **Available Units of Measurement** on page 62 for the list of available units.
ACCEPT UNITS	The Accept Units prompt will only appear if one or more of the units have been changed. **IMPORTANT:** Accepting the change of units will initiate a master reset. All calibration parameters will revert to their default value (i.e. those values included in the downloaded instrument software). All totals and any logged information will be cleared. Press ▲ or ▼ to select YES, then press the SET key. The instrument makes three beeps to confirm the reset command. The message -RESET- PLEASE WAIT will be displayed as the instrument exits calibration mode and completes a full re-boot sequence.

Parameters

SET ↓	▶ → UNITS **PARAMS** INPUTS OUTPUTS COMMS TM/LOG SETUP TEST END
BATCH LIMIT	The batch limit determines the maximum batch preset value that can be entered. If a value of zero is entered for this parameter then no limit is applied. Enter the value in the engineering units of the batch preset.
P-STOP VALUE	The prestop value determines when relay 2 deactivates as the batch approaches the preset quantity. Enter the value in the engineering units of the batch preset.
ACCEPT TOTAL	The batch acceptable total is the minimum total for the system leakage to be logged (a value of zero disables logging of leakages). It also allows small totals due to “meter skips” and vibration to be discarded without being considered as a valid delivery. Enter the value in the engineering units of the batch preset.
S-STRT SEC	The batch slow start time determines when relay 2 activates after the start or resumption of a batch. Enter the value in seconds.
A-STRT SEC	The batch automatic restart time determines the time that will elapse between the end of one batch and the start of the next. A value of zero disables the auto restart feature. Enter the value in seconds.
T-OUT SEC	The batch flow timeout determines the length of no flow time that the instrument will wait during a batch before raising a no flow error. It also determines when an overflow error is raised if flow does not cease within the timeout period after the controller attempts to stop the flow. A value of zero disables these flow timeout features. Enter the value in seconds.
COUNT DIR	The batch count direction determines whether the batch total counts up from zero to the preset value or down from the preset to zero. Press ▲ or ▼ to select UP or DOWN.

SET ↓	▶ → UNITS **PARAMS** INPUTS OUTPUTS COMMS TM/LOG SETUP TEST END
AUTO RESET	*This parameter is available for viewing and editing only when the batch automatic restart time is set to zero.* The automatic reset feature allows the previous batch total to be reset automatically when a new batch is started with the RUN key. Press ▲ or ▼ to select ENABLE or DISABLE.
AUTO COMP	The batch automatic overrun compensation allows the instrument to automatically compensate for any consistent overrun at the end of the batch. Overrun is typically due to the slowness of a valve to close or a pump to stop on receiving a signal from the batch controller and results in the delivered quantity being greater than the entered preset. In calculating the amount to be compensated for the instrument uses the average overrun from the last three batches. An overrun of more than 20% is considered invalid and will not be included in the calculations. Press ▲ or ▼ to select ENABLE or DISABLE.
STOP KEY	The function of the Stop key can be set to either Pause or Stop the delivery. Press ▲ or ▼ to select PAUSE or STOP.
No-SET BATCH	To provide faster access to commonly used preset values a number of batch presets can be preprogrammed into the instrument. This parameter allows the number of batch presets to be entered. Press ▲ or ▼ to select a number between 1 and 10.
SET-01 BATCH *to* SET-*n*	Enter the commonly used preset values for quick access via the front panel. Enter the value in the engineering units of the batch preset.
DIRECT ACCES	If the direct access is enabled then the operator is able to enter edit mode for the batch preset directly from the main menu by holding the SET key while viewing the preset. If disabled, the changes can only be made from within the calibration set mode (or via serial communications, see below). Select the direct access mode as required. Press ▲ or ▼ to select ENABLE or DISABLE.

SET ↓	▶ → UNITS **PARAMS** INPUTS OUTPUTS COMMS TM/LOG SETUP TEST END
Modbus Accessible Parameters The following PARAMS menu items are also accessible via Modbus communications. For a complete Modbus parameter listing, refer to **Instrument Configuration Parameters** on page 53.	
PRESET BATCH	Enter the batch preset quantity. This setpoint is only available for PRESET batch mode. Enter the value in the engineering units of the assigned variable.

Inputs

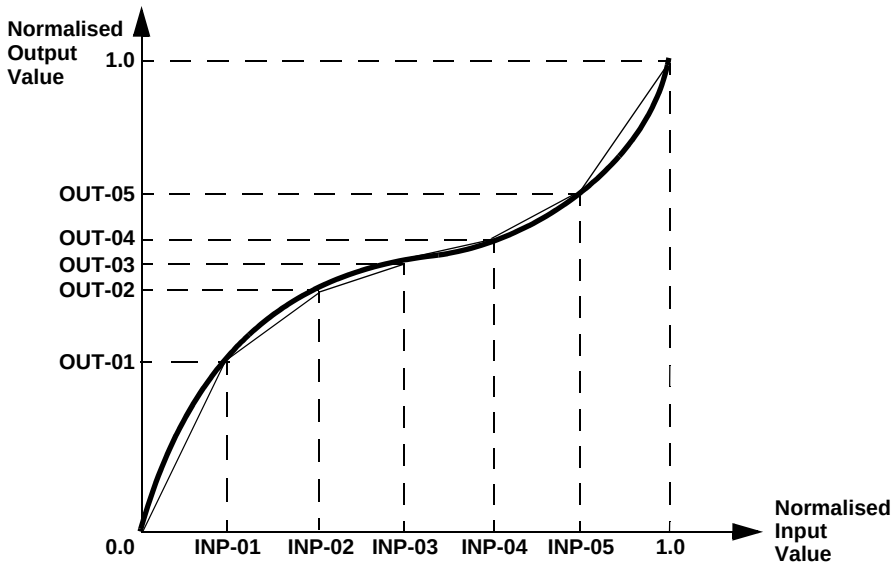
SET ↓	▶ → UNITS PARAMS **INPUTS** OUTPUTS COMMS TM/LOG SETUP TEST END
Analog Input	
INPUT M-FLOW AINP	For this application, the Analog Input is assigned to mass flowrate.
TYPE AINP	This step identifies the type of analog input source. For model 505 instruments the input is fixed to 4-20 mA.
PT-MIN AINP PT-MAX	Enter the value of the measured parameter (in the assigned engineering units) that corresponds to the minimum input signal level. The minimum point is commonly set at a base flowrate of 0.0. Enter the value of the measured parameter (in the assigned engineering units) that corresponds to the maximum input signal level. The maximum point is the same as the base value (set at the minimum point) plus the span value. For example, if the source signal is 4 mA at a minimum mass flowrate of 0 kg/M, enter 0 as the minimum point. If the source signal is 20 mA at a maximum mass flowrate of 100 kg/M, enter 100 as the maximum point.
CUTOFF AINP	The Cut-off is the lowest value that the instrument reads from the input sensor. The cut-off setting is the percentage of the span of the input values. All inputs at or below the cut-off value are considered negligible to the instrument and are ignored. In this case, the instrument uses the minimum value (set at PT-MIN).

<table>
<tr><td>SET ↓</td><td>▶ → UNITS PARAMS INPUTS OUTPUTS COMMS TM/LOG SETUP TEST END</td></tr>
<tr><td>FILTER AINP</td><td>Input fluctuations caused by pulsating flow tend to create distortion in the input readings of the rate. The instrument has a digital filter that averages out these fluctuations.

As a guide to the degree of filtering to use, the following table shows the response time (in seconds) to reach 90% and 99% of a step change in input.

The value A is the filter constant that the user can set.</td></tr>
<tr><td></td><td>
<table>
<tr><th>Filter setting A</th><th>Seconds to reach 90% of full swing</th><th>Seconds to reach 99% of full swing</th></tr>
<tr><td>0</td><td>0</td><td>0</td></tr>
<tr><td>2</td><td>2</td><td>4</td></tr>
<tr><td>4</td><td>4</td><td>8</td></tr>
<tr><td>6</td><td>5</td><td>10</td></tr>
<tr><td>10</td><td>8</td><td>15</td></tr>
<tr><td>15</td><td>12</td><td>23</td></tr>
<tr><td>20</td><td>14</td><td>27</td></tr>
<tr><td>25</td><td>18</td><td>34</td></tr>
<tr><td>35</td><td>25</td><td>48</td></tr>
<tr><td>45</td><td>32</td><td>62</td></tr>
<tr><td>60</td><td>42</td><td>82</td></tr>
<tr><td>75</td><td>52</td><td>102</td></tr>
<tr><td>90</td><td>62</td><td>122</td></tr>
<tr><td>99</td><td>68</td><td>134</td></tr>
</table>
The input filter range is from 0 to 99. A setting of 0 (zero) means that there is no filtering.</td></tr>
<tr><td>CORR AINP</td><td>Analog input non-linearity can be corrected as follows:
• LINEAR
• SQUARE is used if the flowmeter requires square root extraction
• NON-LINEAR to use the following linearity correction parameters

Use ▲ or ▼ to select LINEAR, SQUARE or NON-LINEAR.</td></tr>
</table>

SET ↓	▶ → UNITS PARAMS **INPUTS** OUTPUTS COMMS TM/LOG SETUP TEST END
NO-PTS AINP	*This parameter is available for viewing and editing only when the correction type is set to Non-linear.* Enter the number of non-linearity correction points. Press ▲ or ▼ to select a number between 1 and 20 for the number of correction points.
INP-01 AINP *to* INP-*n*	*This parameter is available for viewing and editing only when the correction type is set to Non-linear.* Enter the normalised input value for the correction point. The instrument uses linear interpolation between the correction points. An input and an output value are entered for each correction point. The values are normalised between the minimum point (0.0) and the maximum point (1.0). Only the points between 0 and 1 are required to be entered and should be entered in ascending order. The following diagram shows a 5 point linearised representation of the input from a hypothetical transmitter. The heavy black line represents the actual input from the transmitter. The light black line is the approximation that the instrument uses.  You can press the DISPLAY key to skip the non-linear points and go to the next item.
OUT-01 AINP *to* OUT-*n*	*This parameter is available for viewing and editing only when the correction type is set to Non-linear.* Enter the normalised output value for the correction point.

Outputs

SET ↓	▶ → UNITS PARAMS INPUTS **OUTPUTS** COMMS TM/LOG SETUP TEST END
FUNC OUT*n*	The digital output can function as either a pulse output for retransmission of totals, a no flow error signal, a pump control output or an end of batch signal. Press ▲ or ▼ to select RETRANS, OP-ERR, OP-CTRL or OP-END
PULSE OUT*n*	*The Output Assignment and associated parameters are available for viewing and editing only when the Output Functionality has been set for retransmission.* You can assign any of the "total" main menu variables to a pulse output. Press ▲ or ▼ to select the variable that is required as an output.
WIDTH OUT*n*	Pulse output is usually used to drive remote counters. Set the pulse width (in milliseconds) as required by the remote counter. Press ▲ or ▼ to set to: 10, 20, 50, 100, 200 or 500 ms.
PULSE OUT*n*	The Output Pulse Factor is the scaling factor for the retransmission of the measured total quantity. For example, if "volume" is chosen as an output variable and engineering unit is cubic metres, then a pulse factor of 1.000 generates one pulse for $1 m^3$. Similarly, a pulse factor of 3.000 generates one pulse for $3 m^3$. For more information, see **Output Pulse Factor** on page 36. The output pulse factor cannot be 0 (zero).
4-20 A-OUT	You can assign any of the "rate" main menu variables to the 4-20 mA output. Press ▲ or ▼ to select the variable that is required as an output.

SET ↓	▶ → UNITS PARAMS INPUTS **OUTPUTS** COMMS TM/LOG SETUP TEST END
PT-MIN A-OUT PT-MAX A-OUT	The output minimum value corresponds to the 4 mA point and the output maximum value corresponds to the 20 mA point. Setting the output range differently from the input range enables the instrument to amplify the input signal. You can drive a chart recorder that "zooms in" on a specified range of values instead of displaying the full operating range of the transducer. For example, if "volume flow" is chosen as an output variable and engineering unit is cubic metres per minute, then setting the minimum point to 30 and the maximum point to 100 would reflect the volumetric flow rate range of 30 to 100 m^3/min. At rates above the maximum and below the minimum points, the output remains at 20 mA and 4 mA respectively.

Output Pulse Factor

Increasing the output pulse width reduces the maximum frequency at which a total variable can be retransmitted. Pulses will be missed if the output cannot "keep up" with the rate of total counts. You can use the output pulse factor to ensure that this maximum is not reached.

The maximum pulse output frequency is determined by:

$$\frac{1000}{(2 \times \text{pulse width in ms})}\text{Hz}$$

The minimum pulse factor required is determined by:

$$\frac{\text{max rate of total}}{\text{max pulse output frequency}}$$

For example: To calculate the required pulse factor to avoid losing counts in retransmission if a total counts at a maximum rate of 75 units/sec (Hz) and the required pulse width of a remote counter is at least 50 ms:

The maximum pulse output frequency is: $\frac{1000}{2 \times 50} = 10\text{Hz}$

The minimum pulse factor for that frequency is: $\frac{75}{10} = 7.5$

Communications

The instrument has three communication ports:

- **RS-232 Port** - Three terminals on the rear of the instrument. There is also an optional 9-pin female connector on the rear panel of the instrument.
- **Infra-red Port** (optional) - Located on the front panel, below the status indicators.
- **RS-485 Port** - Terminals on the rear panel.

SET ↓	▶ → UNITS PARAMS INPUTS OUPUTS **COMMS** TM/LOG SETUP TEST END
PROTOC RS232 RS485 INFRA	The Communications Protocols can be assigned to the communication ports as follows (a protocol cannot be assigned to more than one port at a time): • **RTU** - Modbus RTU available for all ports • **PRN** - Printer Protocol available for RS232 and RS485 • **NONE** - If a port is not being used, set the protocol to NONE. Printer Protocol (PRN) is only available if the option with Real Time Clock is installed. For the selected port, press ▲ or ▼ to select the desired protocol.
BAUD RS232 RS485 INFRA	The Baud setting is the speed of the communication port in data bits per second. The baud rate of the instrument must match the baud rate of the communication device that the instrument is connected to. Use ▲ or ▼ to select 2400, 4800, 9600 or 19200 baud.
PARITY RS232 RS485 INFRA	The Parity bit helps to detect data corruption that might occur during transmission. The parity bit setting of the instrument must match the parity bit setting of the communication device that the instrument is connected to. Press ▲ or ▼ to select EVEN, ODD, or NONE.
S-BITS RS232 RS485 INFRA	The Stop bit indicates the end of a transmission. Stop bits can be 1 or 2 bit periods in length. The stop bit setting of the instrument must match the stop bit setting of the communication device that the instrument is connected to. Press ▲ or ▼ to select 1 or 2 stop bits.

SET ↓	▶ → UNITS PARAMS INPUTS OUPUTS **COMMS** TM/LOG SETUP TEST END
RTU DATA	The Modbus RTU data format for the 2-register (4-byte) values can be set as either floating point or long integer values. Use ▲ or ▼ to select FLOAT or INTEGER.
RTU ADDR	The Modbus RTU protocol address must be in the range of 1 to 247. When multiple instruments (slaves) are connected to one communication device (master), each assigned address must be unique. **Note:** The master device uses the RTU address 0 (zero) for broadcasting to all connected slave units.
FLASH PORT	The Flash Driver Port assignment defines the communication port for downloading software into the instrument. The default setting of this assignment is the RS-232 port. Press ▲ or ▼ to select RS-232, RS-485, or INFRA.

Time Settings and Data Logging

Instrument Clock

Note: The real-time clock is part of the advanced option package.

The instrument has a real-time clock for recording logged events. The clock displays the time and the date. The date format can be set to European format (day/month/year) or American format (month/day/year). The time clock uses the 24-hour format.

The clock will continue to operate for up to 5 years (typically) on the internal battery if there is no power connected to the instrument. Therefore, after an interruption to the power supply, the instrument recommences normal operation although there will be no data recorded during the period without a power supply.

Note: If there is an interruption to the power supply and the battery has failed, the instrument displays an error message when the power supply is restored. In this case, you should set the current time and date so that the instrument continues to log data at the correct times.

Data Logging

The instrument will log a total of 100 deliveries (batches) if the real-time clock option is installed. The logs are taken at the end of each batch or upon reset if a batch has been aborted before the preset total has been reached.

SET ↓	▶ → UNITS PARAMS INPUTS OUPUTS COMMS **TM/LOG** SETUP TEST END
DATE FORM	Clock Date Format The European date format is: dd/mm/yyyy or (Day-Month). The American date format is: mm/dd/yyyy or (Month-Day). Press ▲ or ▼ to select DAY-M or M-DAY
CLOCK YEAR	The Clock Year defines the current year for the real-time clock.
CLOCK M-DAY	The Clock M-DAY setting defines the current month and date for the real-time clock. This parameter is programmed in Month-Day format for both European and American date formats.
CLOCK H-MIN	The Clock H-MIN setting is the current time in hours and minutes for the real-time clock.
RESET LOGS	Reset the logged data. You may need to reset (clear) the logged data if you change the time/log settings. Press ▲ or ▼ to select YES, then press the SET key. The instrument makes three beeps to confirm the reset command.
REPORT LOGS	The Printer Protocol Report Logs defines the number of latest logs to be included into a printable report. Enter the number of logs between 0 and 99.
REPORT TYPE	The Printer Protocol Report Type determines the nature of the printout from the REPORT PRINT - HOLD.SET prompt in the main menu. The following report types available in this instrument are: • REP-10 Preset number of latest logs Press ▲ or ▼ to select Report Type.
PRN TYPE	The Printer Protocol Printer Type allows the nature of the printer being used to be specified. The following printer types available in this instrument are: • PRN-01 Generic computer printer • PRN-02 Generic roll printer (prints first line first) • PRN-03 Slip printer TM295 Press ▲ or ▼ to select Printer Type.

General Setup Parameters

SET ↓	▶ → UNITS PARAMS INPUTS OUPUTS COMMS TM/LOG **SETUP** TEST END
DEFAULT VAR	Select the main menu variable to display on power up or when the display timeout period has elapsed if it is enabled. Press ▲ or ▼ to select the default variable display.
SUPPLY VOLT	The instrument provides a power-limited supply for external transducers. Press ▲ or ▼ to set the transducer supply voltage between 8 and 24 volts DC as required.
T-OUT MODE	If the Display Timeout mode is enabled, and there is no user activity for the defined timeout period, the display panel returns to the default display. This function is useful for the following reasons: • to return the display to a preferred variable after the user has finished reading other information, • to cancel the calibration mode and return to the default display if the user does not exit from the calibration mode for any reason. Press ▲ or ▼ to select the display timeout function as follows: • **DISABLE** - Timeout is completely disabled. • **EN DISP** - Timeout is enabled during Normal mode and Calibration View mode. • **EN EDIT** - Timeout is enabled during Calibration Set mode. • **EN ALL** - Timeout is enabled for all modes.
T-OUT SEC	The Display Timeout period defines the delay for the Display Timeout mode if it is enabled. The display timeout period can be from 10 to 99 seconds.
RESET ACCUM	The Reset Accumulated Totals function clears all of the accumulated totals and the non-accumulated totals. Press ▲ or ▼ to select YES, then press the SET key. The instrument makes three beeps to confirm the reset command.

SET ↓	▶ → UNITS PARAMS INPUTS OUPUTS COMMS TM/LOG **SETUP** TEST END
DISPL TAGS	The Display Tags option determines whether the instrument displays the default display tags or the user-defined tags. The display tag setting also defines whether the instrument displays the default error and warning messages, or the user-defined messages. **Note:** The user-defined tags can be entered into the instrument only by the manufacturer or the distributor. Press ▲ or ▼ to select the Display Tags option as follows: • **DEFAULT** - the instrument displays the default (English) tags • **USER** - the instrument displays the user-defined tags.
BACK-L T-OUT	If the backlight timeout is enabled, and there is no user activity (any keys pressed) for a period of 10 seconds, the display backlight switches off to save power. The backlight switches on when a key is pressed. Select the backlight timeout mode as required. Press ▲ or ▼ to select ENABLE or DISABLE.
RATES DP	This parameter sets the maximum number of decimal places for displaying or printing main menu rates.
TOTALS DP	This parameter sets the maximum number of decimal places for displaying or printing main menu totals.

Test Menu

The Test menu enables you to view the inputs and outputs to and from the instrument.

In Calibration Set mode, (by entering the system password) you can control the outputs and the alarms as described in the table below.

SET ↓	▶ → UNITS PARAMS INPUTS OUPUTS COMMS TM/LOG SETUP **TEST** END
AINP mA	The current of the signal input to AINP is displayed in milliamps.
LINP*n* STATE	You can view the state of the logic input. If the input is an open contact or inactive it will display **HI**. If the input is a closed contact or active it will display **LO**.

SET ↓	▶ → UNITS PARAMS INPUTS OUPUTS COMMS TM/LOG SETUP **TEST** END
OUT*n* STATE	You can control the state of the outputs. Press the ▲ or ▼ keys to set the output state as follows: • **PROCESS** - the output depends on the current values of the inputs and the calculations that the instrument performs. • **ON** - the output is a pulse train with a pulse width as set for the particular output in the Outputs menu. • **OFF** - no output.
A-OUT STATE	You can control the state of the outputs. Press the ▲ or ▼ keys to set the output state as follows: • **PROCESS** - the output depends on the current values of the inputs and the calculations that the instrument performs. • **HI** - the output is set to 20 mA. • **LO** - the output is set to 4 mA.
ALRM*n* STATE *or* REL-*n*	You can control the state of the relays (alarms). Press the ▲ or ▼ keys to set the selected relay as follows: • **PROCESS** - the relay operates according to the current values of the inputs and the relay settings as programmed. • **OPEN** - the relay output contacts are set to “open”. • **CLOSED** - the relay output contacts are set to “closed”.
SUPPLY V	You can display the actual DC output supply voltage, which may help with troubleshooting. If the actual supply voltage is lower than the preset value (refer to **General Setup Parameters** on page 40) it may indicate that the output is overloaded.

System Messages

The instrument displays messages for defined events and fault conditions.

The manufacturer or distributor can enter user-defined text for the messages. This user-defined text is displayed, instead of the default (English) messages, when the Display Tags option in the Setup menu is set to USER.

Error Messages

The system displays error messages as described in the following table:

Error Messages	Description
CPU Card Failure	There are failed components on the CPU card and technical support is required.
Power Supply is Low	The input and/or output power supply voltage is too low, ensure that: (a) input power supply voltage is within the specified range (b) output power supply is not overloaded.
New/Failed Battery - Set Time	The real-time clock has lost the correct time because the battery has failed, or there is a new battery. Set the current time and date (in the TM/LOG menu) to clear the error message and to continue data logging at the correct times. **Note:** The instrument can continue operating with a failed battery, but the correct time will be lost if there are interruptions to the power supply.
Flowrate Input Failure	The flowrate sensor (analog input) has failed. It is not possible to override this error condition. The instrument cannot operate without a flowrate input.
No Flow Detected	The no flow condition is detected when the flow timeout expires during a delivery. There must not be a period of no flow greater than the timeout value during the delivery.
Overflow Detected	The overflow condition is detected when the flow continues longer than the timeout period after the controller has attempted to stop the flow.
Leakage Detected	The leakage condition is detected when an amount greater than the acceptable total is received without flow being initiated by the batch controller.

Warning Messages

The system displays warning messages as described in the following table:

Warning Messages	Description
Value Has Been Set to Default	You have entered an invalid value for a parameter. Therefore, the instrument has set the default value.

Warning Messages	Description
Already Assigned to Other Port	You have tried to assign a particular protocol type to more than one serial communication port. The instrument has set the protocol to NONE.
Preset Over Limit - Max Set	You have exceeded the preset limit. The instrument will set the maximum allowed value.

Chapter 6
Communications

Overview

This chapter describes the communications between the instrument and another communicating device such as a computer or a printer. You should have relevant information about the devices to which the instrument will be connected. Some connection examples are included in this manual, however, the operation and connection of other devices is outside the scope of this manual.

Hardware Interconnection

The instrument has three communication ports:

- RS-232 port on the rear panel (plus extra DB9 female connector)
- RS-485 port on the rear panel
- Infra-red port on the front panel (optional)

The appropriate interface and protocols are selected during calibration.

RS-232 Port

The RS-232 port provides communication between the instrument and one other device such as a host computer or a printer.

Note: A printer must have a serial port to be able to be directly connected to the flow computer. It is not possible to communicate directly with a printer via a parallel port.

Computers use either a DB9 or a DB25 connector, and the connections to each type are shown in Figure 16.

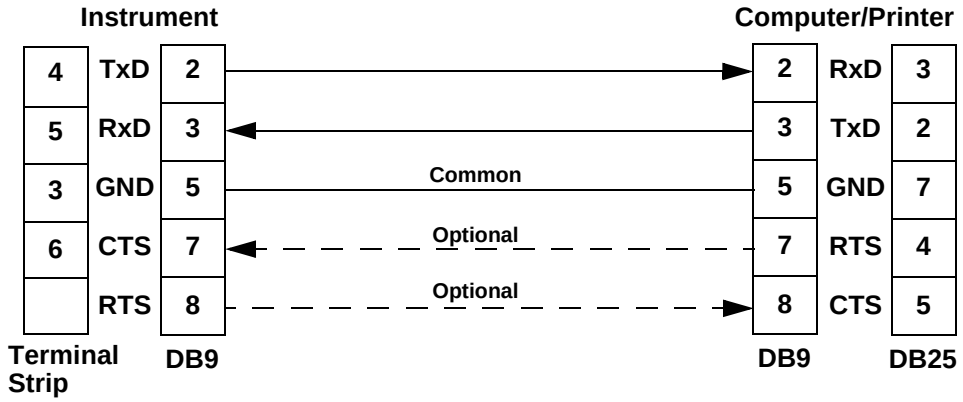


Figure 16 RS-232 Cable Connections to a Computer

Note: The instrument requires a cable with straight-through connections. Do not use a null modem cable for RS-232 connection to a computer.

RS-485 Port

The RS-485 port enables communication with multiple devices. Each device has a unique address so that the "master" device can communicate with specific "slave" devices.

On RS-485 links, an external terminating resistor must be connected at the furthest end of the cable. When multiple instruments are connected, they should be "daisy chained" in a multidrop configuration as shown in Figure 17. Up to 32 units can be connected to the interface at a maximum distance of 1200 metres.

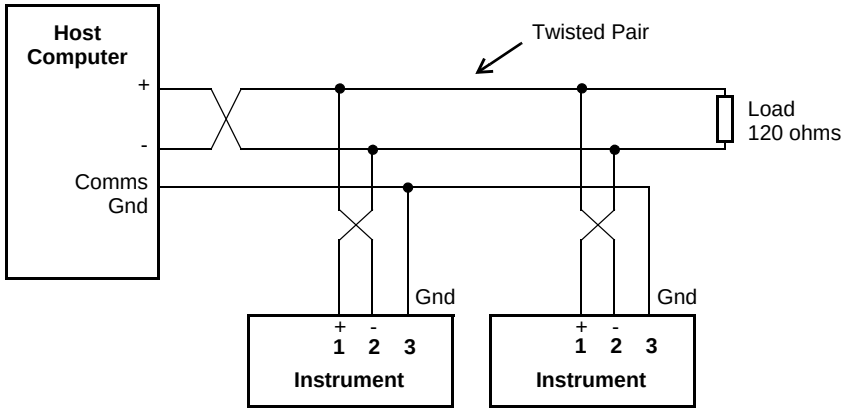


Figure 17 RS-485 Connections

Infra-red Port

The infra-red port is located on the front panel of the instrument. The infra-red port uses the Infra-red Developers Association (IrDA) physical layer format of signal encoding and decoding.

The nature of the infra-red port requires the communicating device to be located close to the front of the instrument. Therefore, its main use would probably be for reloading the instrument application software, or occasional collection of data, rather than continuous communications.

Protocols

The communications protocols can be assigned to the communication ports on the instrument as follows:

- **RTU** - Modbus RTU available for all ports
- **PRN** - Printer Protocol available for RS232 and RS485
- **NONE** - If a port is not being used, set the protocol to NONE.

Note: The Printer Protocol is only available if the option with Real Time Clock is installed. Also a protocol cannot be assigned to more than one port at a time as described in **Communications** on page 37.

- **Modbus RTU** - Modbus RTU is an industry-standard protocol which allows the instrument to be easily connected to computers running supervisory software systems.
- **Printer** - In the Printer protocol there is a selection of printer types. Please refer to the **Printer Protocol** on page 54 for full details.

Modbus RTU Protocol

Modbus RTU (remote terminal unit) is an industry standard protocol that allows the instrument to be easily interfaced to other communication devices.

The instrument implements the Modbus protocol as detailed in the *Modicon Modbus Protocol Reference Guide* PI-MBUS-300 Rev J (June 1996).

Message Format

In RTU mode, messages start with a silent interval of at least 3.5 character times. The first field transmitted is the device address. Following the last transmitted character, a similar interval of at least 3.5 character times marks the end of the message. A new message can begin after this interval. The entire message frame must be transmitted as a continuous stream. A typical message frame is shown below:

Address	Function	Data	CRC Check
1 byte	1 byte	n bytes	2 bytes

Except for broadcast messages, when a master device sends a query to a slave device, it expects a normal response. One of four possible events can occur from the master’s query:

- If the slave device receives the query without a communication error, and can handle the query normally, it returns a normal response.
- If the slave does not receive the query due to a communication error, no response is returned. The master program has to process a timeout condition for the query.
- If the slave receives the query, but detects a communications error (parity or CRC), no response is returned. The master program has to process a timeout condition for the query.
- If the slave receives the query without a communication error, but cannot handle it (for example, if the request is to read a nonexistent register), the slave will return an exception response informing the master of the nature of the error.

Instrument Address

The address of the instrument is programmable in the range from 1 to 247. Some addresses are reserved according to PI-MBUS-300 and have a special meaning:

- 0 = Broadcast, no response required from slave devices
- 248 to 255 Reserved

Function Codes

The instrument accepts the following function codes:

Code	Name	Description
03	Read data register(s)	Obtain the content of one or more 2-byte data registers.
06	Preset data register	Preset one 2-byte data register.
07	Read status register	Obtain the content of 1-byte status register.
16	Preset data register(s)	Preset one or more 2-byte data registers.

Exception Response

The instrument forms an exception response by adding 80H to the function code and using an exception code as the 1-byte data field in the returned frame. Implemented exception codes are as follows:

Code	Name	Description
01	Illegal function	The function code is not a legal action for the slave.
02	Illegal data address	The data address is not a legal address for the slave.
03	Illegal data value	The data value is not a legal value for the slave.
05	Acknowledge	The slave has accepted the request and is processing it, but a long duration of time will be required to do so.
06	Slave device busy	The slave is engaged in processing a long duration program command. The master should re-transmit the message later when the slave is free.

List of Data Registers

The following list describes the addresses and meaning of the data registers in the instrument. The data values are expressed in the engineering units that were selected for the variables when the instrument settings were configured. The “Data Type” for the 2-register (4-byte) data values can be set in programming mode as Floating Point or Long Integer as described in **Communications** on page 37.

The registers are grouped in blocks that relate to a particular function of the instrument.

Note: Conventional numbering of registers often starts from 1, therefore be aware that “register 1” in this case has “address 0” and so on.

Current and Logged Process Data

This block of registers is available for the retrieval of current or logged process data with its matching time and date information.

Use the log timebase and log number to retrieve the logged information from the appropriate register. If a particular log number does not exist, or the instrument does not have the optional real-time clock, the time and date stamp and associated variables are set to zero.

Register	Name	Comments	Read Only or Read/Write	Type
1	Mass	Process Variables By default totals are the Accumulated values. If current Non-accumulated (resettable) totals are required, set register 37 to 06.	R	DT*
3	Mass Flowrate		R	DT
5			R	DT
7			R	DT
9			R	DT
11			R	DT
13			R	DT
15			R	DT
17			R	DT
19			R	DT
21			R	DT
23			R	DT
25			R	DT
27			R	DT
29			R	DT
31	Year	Current Date/Time or Logged Date/Time Stamp (see register 38 Log Number). Only current Date/Time can be edited	R/W	I†
32	Month		R/W	I
33	Date		R/W	I
34	Hour		R/W	I
35	Minute		R/W	I
36	Second		R	I
37	Log Type	00 - hourly or log records 01 - daily 02 - weekly 03 - monthly 04 - yearly 05 - last edit of calibration 06 -current totals are non-accumulated values, register 38 is ignored.	R/W	I
38	Log Number	If set to 0, current variables and Date/Time are retrieved	R/W	I
39	Clear Data	01 - clear logs 02 - clear accumulated totals 03 - clear non-accumulated totals	W	I
40	Reserved			

* DT = Data Type of 2-register (4 byte) values can be set as Floating Point or Long Integer values

† I = Integer (2 bytes) (Holding Registers)

Note: The Floating Point variable is represented in IEEE-754 Floating Point 4-byte format and requires two 2-byte data registers:

IEEE-754	Modicon Registers
1st byte	low byte (register X)
2nd byte	high byte (register X)
3rd byte	low byte (register X+1)
4th byte	high byte (register X+1)

This means that two data registers must be read or written to obtain, or preset, one data value.

Instrument Exception Status

This register is available to verify the status of the instrument.

Register	Name	Comments	Read Only or Read/Write	Type
41	Exception Status	00 = no error 01 = analog input 1 failure 02 = analog input 2 failure 03 = analog input 3 failure 04 = analog input 4 failure 05 = invalid calibration parameter 06 = invalid reference parameter 07 = invalid property 08 to 09 reserved 10 = process parameters out of range 11 = input is over limit 12 = no flow error detected 13 = overflow error detected 14 = leakage error detected 20 = system failure 21 = power supply is low 22 = new or failed clock battery 23 to 29 reserved 30 = alarm 1 active 31 = alarm 2 active 32 = alarm 3 active 33 = alarm 4 active	R	I*

* I = Integer (2 bytes) (Holding Registers)

Instrument Control and I/O

This block of registers is available in some applications to give access to important information in the instrument.

Register	Name	Comments	Read Only or Read/Write	Type
42	Reserved		R	I*
43	Reserved			

Register	Name	Comments	Read Only or Read/Write	Type
44	Operation State	Representation of operation status 0 = Reset 1 = Maintenance 2 = Completed 3 = Waiting to restart 4 = Paused 5 = Waiting for timeout 6 = Running (Slow Start) 7 = Running (Prestop) 8 = Running (Full Flow)	R	I
45 to 47	Reserved			
48	Delivery Number	Provides the delivery number (batch record) for a stored transaction (determined by Modbus register 38).	R	L†
50	Control Mode	0 = Idle/Local Control from logic inputs 1 = Stop Suspend current batch 2 = Run Resume/start batch 3 = Reset Clear current batch totals	R/W	I
51 to 99	Instrument Parameters	See next table for details.	R/W	DT‡
101	Analog Input	The input is configured for 4-20mA. The value will be read in Amperes.	R	DT

* I = Integer (2 bytes) (Holding Registers)

† L = Long Integer (2 register = 4 bytes)

‡ DT = Data Type of 2-register (4 byte) values can be set as Floating Point or Long Integer values

Instrument Configuration Parameters

This block of registers is available in applications to give access to some important instrument parameters (i.e. fluid properties etc.).

The usage of these parameters can be dependent on other instrument settings. For full description, please refer to the **Modbus Accessible Parameters** on page 32.

Register	Name	Comments	Read Only or Read/Write	Type
51	Batch Preset Value		R/W	DT
53 to 99	Reserved		R/W	DT

Printer Protocol

A printer protocol is available in the 500 Series. It provides the ability to print out live data, individual logged data and to do some report-style printing of logged data. The method of printing these and the format of the printouts is described below.

Note: Printer output is only available if the Real Time Clock option is fitted.

The selection of Printer Protocol can be made for the Communications Protocol options for the RS232 or RS485 port. A list of log report types and printer types available at the end of the TM-LOG calibration menu.

Report Types

The list of report types is as follows:

- REP-10 Latest Logs Report

The number of logs printed in each report are determined by the values programmed for Report Logs in the TM-LOG menu.

Printer Types

The list of available printers is as follows:

- PRN-01 Generic computer printer
- PRN-02 Generic roll printer (printing first line first)
- PRN-03 Slip Printer TM295

Customizing a Printout

A customized printout can be provided which can have up to 4 header lines and 3 footer lines. It is also possible to include or exclude each main menu items on the printout. If any customizing of the printout is required discuss this with the distributor.

Types of Printouts

Live Data

The RESET key, when in main menu, is shared as the PRINT key if the printer protocol has been selected. A printout will be initiated whenever this key is pressed. If printing is not required, do not select printer protocol.

The format of this printout will be:

Custom Header Line 1
Custom Header Line 2
Custom Header Line 3
Custom Header Line 4

Current Docket No.

Instrument Serial No. & Tag

Current Date & Time & Status
Variable unit value
Variable unit value
etc.

Custom Footer Line 1
Custom Footer Line 2
Custom Footer Line 3
---------- *<separation line>*

(Note that blank header and footer lines are not printed).

Docket Number

The docket number that appears on the live data printout indicates the print number. This number is cleared when the Accumulated totals are reset. If the Reset Mode is set for Delayed, where a print can be generated without resetting the non-accumulated totals, an additional number in brackets will be shown that indicates the number of prints since the last reset. i.e.

DOCKET No. 000256 (000036)

Instrument Serial Number and Unit Tag

The instrument serial number and unit tag is the same as the information shown in the Model Info menu. For more details refer to **Model Information** on page 18

Individual Log Data

When in the Log Menu and while holding the DISPLAY key to view the data of the log of interest the RESET key can be pressed to initiate a printout of that log entry. The printout will have the time and date stamp corresponding to when the log was taken. After the print has been initiated there will be the opportunity to scroll to view another log entry and print again.

Since each log entry stores the delivery totals only, the printout will not have any accumulated totals. The format of the printout with this exception is the same as the LIVE DATA printout:

Custom Header Lines

Instrument Serial No. & Tag

Delivery No. Date & Time & Status
Variable unit value
Variable unit value
etc.

Custom Footer Lines
---------- *<separation line>*

Log Report Printing

As there is the likelihood that the reports can be of a considerable length it is strongly recommended that only the 80 Column printer with Z fold (tractor feed) paper be used. This is just as much for the memory storage of printer as it is for the reliable paper supply.

There is a HOLD.SET REPORT PRINT prompt under the main menu with the ability to print the pre-selected type of report. Pressing and holding the SET key for two seconds will initiate the printout. Any of the Log Reports will have the following format:

Custom Header Lines

Title of Report *<internally set, indicates report type>*

Current Date & Time
Instrument Serial No. & Tag

---------- *<separation line>*
Delivery No. Date & Time & Status
Variable unit value
Variable unit value
etc.

---------- *<separation line>*
Delivery No. Date & Time & Status
Variable unit value
Variable unit value
etc.

---------- *<separation line>*
Delivery No. Date & Time & Status
Variable unit value
Variable unit value

ETC

Custom Footer Lines
---------- <*separation line*>

Reports such as “Latest Logs” will print in the historical order, and for those logs that have no data (e.g. unit was powered off at the time) the print will show “Data not available”. i.e.

---------- <*separation line*>
Del No. Data Not Available

---------- <*separation line*>
Delivery No. Date & Time & Status
Variable unit value
Variable unit value
etc.

If the unit is programmed for 0 logs for the latest log reports then the report will only consist of the header and ID information and a “Data Not Available” message.

Custom Header Lines

Title of Report

Current Date & Time
Instrument Serial No. & Tag

Data Not Available

Custom Footer Lines
---------- <*separation line*>

Printer Data Control

Some printers have limited data buffers and are therefore unable to collect all the print data being transmitted. The 500 Series has the capability of software handshaking. The Xon/Xoff characters can be used by any of the printer types to control the flow of data to ensure that data is not lost.

Some printers will also transmit an Xoff character in response to other events such as printer being off-line, print head not engaged or power being removed. The specific behaviour of the printer being used should be noted.

Error Messages

There are two printer error messages that can be displayed.

PAPER OUT

This message is related to the Printer Type PRN-03 TM295 Slip printer. It is standard procedure with this printer to check for paper status before printing. If a print is attempted but there is no paper the PAPER OUT message will be scrolled. The instrument will continue to poll the printer for paper and if paper is detected before a communications timeout expires the print will commence.

COMMS TIMEOUT

This message is relevant for all printer types and will be activated for the following conditions.

1. If the flow of data is stopped due to software or hardware handshaking and is not allowed to resume before the communications timeout.

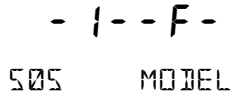
2. If Printer Type is PRN-03 Slip printer and a paper status is requested but no response is received within the timeout period.

3. Paper Out has been detected for Printer Type PRN-03 but no paper is inserted within the timeout period.

When a communications timeout error has been activated the message COMMS TIMEOUT will be scrolled once, the request to print will be cleared and the instrument will return to its normal mode.

Appendix A
Model Numbers

Product Codes

Model	Supplementary Code						Description
505 .						- BC04	
Enclosure	1						Panel mount enclosure
	2						Field mount enclosure (not yet available)
	3/5						Explosion proof Ex410 with metric glands (5 specifies heater version)
	4/6						Explosion proof Ex410 with NPT glands (6 specifies heater version)
Output Options		0					**Basic** - RS232 and RS485 serial ports, 2 relays, 2 pulse outputs, rear key input
		1					**Advanced** - also includes 4-20mA o/p and Real-time clock for printer output and logging (100 logs)
Extra Options			2				9-way DB connector for RS232 serial port
Power Supply				E			For 220/240VAC
				A			For 110/120VAC
				D			For DC power only 12-28VDC
Display Panel Options					S		Standard (no backlight, LCD backup or Infra-Red comms port)
					F		Fully optioned (with backlight, LCD backup and Infra-Red comms port)
PCB Protection						C	**Conformal coating** - required for maximum environmental operating range. Recommended to avoid damage from moisture and corrosion.
						N	**None** - suitable for IEC standard 654-1 Climatic Conditions up to Class B2 (Heated and/or cooled enclosed locations)
Application Pack Number						BC04	Defines the application software to be loaded into the instrument
For example: Model No. 505.112EFC Displayed on the 500 Series as:(only h/w that affects the operation is represented)							

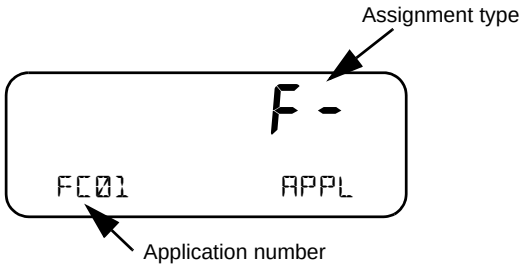
Note: Example full product part number is 505.112EFC-BC04 (This is the number used for placing orders).

Custom Version Codes

	Code		Description
Origin Code **Identifies Distributor**	00		Factory Default Application
	01		Contrec Pty. Ltd. Melbourne Australia
	02		Contrec Pty. Ltd. Sydney Australia
	03		Contrec Europe Ltd. West Yorkshire UK
	04		Contrec - USA, LLC. Pelham AL 35124 USA
	05		Flowquip Ltd. Halifax UK
	06		
	etc.		
User Language	0		English (Default)
	1		German
	2		Dutch
	3		French
	4		Spanish
	5		
	etc.		
Distributor's Code		000 … 999	Distributor's own choice. Possibly a code that identifies the customer and the application.
For example: 02 3 157 Displayed on the 500 Series as:			023157 CUSTOM VERS

Application Information Code

The Application Information code is an aid for users and service personnel to determine the type of inputs that are used in a particular application. The Application Information code is displayed on the instrument as shown below.



The Application number identifies the application as in the following examples:

- BC01 - single channel batch controller for frequency flow input.
- FC01 - single channel flow computer for frequency flow input

The Input Assignment type indicates the physical input that is assigned to each input on the instrument. The code is made up from two characters as follows:

FINP	AINP
X	X

The codes are as follows:

- - - not used in this application
- A - indicates an analog flow input such as for volume or mass
- F - indicates a frequency flow input such as for volume or mass
- L - indicates a level input
- d - indicates a density input
- t - indicates a temperature input.

For example, FL is an instrument with FINP (frequency input) assigned to a flow input, AINP (analog input) assigned to a level input.

Appendix B
Units of Measurement

Available Units of Measurement

The following is a list of the available units of measurement used across the range of 500 Series applications.

Units Type	Available units of measurement
Volume	m^3, Km^3, Ltr, Gal, KGal, MGal, ft^3, kft^3, Mft^3, bbl
Volume Flowrate	m^3/s, m^3/min, m^3/h, m^3/D, L/s, L/min, L/h, Gal/s, Gal/min, Gal/h, KGal/D, MGal/D, ft^3/s, ft^3/min, ft^3/h, Mft^3/D, bbl/s, bbl/min, bbl/h, bbl/D
Volume K-Factor	P/m^3, P/Ltr, P/Gal, P/ft^3, P/bbl
Mass	kg, g, Ton, lb, Klb
Mass Flowrate	kg/s, kg/min, kg/h, g/s, g/min, g/h, Ton/min, Ton/h, Ton/D, lb/s, lb/min, lb/h, Klb/min, Klb/h, Klb/D
Mass K-Factor	P/kg, P/g, P/Ton, P/lb, P/Klb
Energy	kJ, MJ, GJ, kWh, MWh, kBTU, Ton.h, therm, cal, kcal, Mcal
Power	kJ/h, MJ/h, GJ/h, kW, MW, kBT/M, kBT/h, Ton, therm/min, therm/h, kcal/h, Mcal/h
Energy K-Factor	P/kJ, P/kWh, P/kBTU, P/Ton.h, P/therm, P/kcal
Temperature	Deg K, Deg C, Deg F, Deg R
Pressure	Pa, kg/m^2, kg/cm^2, kPa, MPa, mbar, bar, psi, Atm, inH_2O, mmH_2O
Density	kg/m^3, kg/Ltr, lb/ft^3, SG60F
Specific Volume	m^3/kg, L/kg, ft^3/lb
Specific Enthalpy	kJ/kg, BT/lb, cal/g, cal/kg, kcal/kg, Mcal/kg
Reynolds Number	E+0, E+3, E+6 (scaling for unitless variable)
Length (Level)	m, mm, cm, INCH, FOOT
Velocity	m/s, m/M, m/h, ft/s, ft/M, ft/h
Length K-Factor	P/m, P/cm, P/INCH, P/FOOT
Area	m^2, ft^2
Ratio	%
General Input	Pressure, Temperature, Density, Length (Level), Factor

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