

# Model 515 Flow Computer

## Operation Manual

### Application CB01

Blending Controller  
for  
Volumetric Frequency Flowmeters



17 June 2017

## **Model 515 Flow Computer - Operation Manual**

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### **Contrec Limited**

Riverside, Canal Road, Sowerby Bridge,  
West Yorkshire HX6 2AY UNITED KINGDOM  
Tel: +44 1422 829944 Fax: +44 1422 829945  
Email: [sales@contrec.co.uk](mailto:sales@contrec.co.uk)

**Website: [www.contrec.co.uk](http://www.contrec.co.uk)**

### **Contrec Systems Pty Ltd**

5 Norfolk Avenue Ringwood, Melbourne 3134 AUSTRALIA  
Tel: +61 4 413 505 114  
Email: [info@contrec.com.au](mailto:info@contrec.com.au)

### **Contrec - USA, LLC**

916 Belcher Drive Pelham AL 35124 USA  
Tel: +1 (205) 685 3000 Fax: +1 (205) 685 3001  
Email: [contrec@contrec-usa.com](mailto:contrec@contrec-usa.com)



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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 instrument rating plate. Personnel should take all due care to avoid electric shock. For safe operation it is essential to connect a mains safety earth to the A.C. power inlet. Do not operate at altitudes above 2000m.

## **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.

## **Disconnection Device**

When powered from a mains supply this unit requires the provision of a suitable mains isolation device to be accessible near to the installed instrument.



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# Chapter 1

## Introduction

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### Features

- Tailored for volumetric frequency flow input
- Pump demand contact
- Selection of various modes of operation
- Process line control via DCV (digital control valve)
- Remote PERMISSIVE input to control delivery's state
- PRESET and FLUSH volume parameters to automatically adjust ratio setpoint
- Allows for non-linear correction
- Storage of 1000 transactions with time and date stamp
- Selection of second language and user tags
- 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 515 CB01 application is a blending controller measuring the volume flow in a main and process lines using frequency flow inputs.

The blending controller can operate in PRESET, ON-OFF (manual) and RELEASE mode of operation. The latest mode allows for easier tuning of the control loop.

The main and process flows are used to determine the net volume flow. The operator can view the ratio of totals as well as the ratio of flow rates.

The control of the process flow is via a digital control valve. The control responsiveness and flowrate deadband can be adjusted to reduce wear on valves.

## Calculations

Blend Point Location.

The controller caters for blending points before and after the main flowmeter. The process flow is a ratio of the net (combined) flow (0 to 80100% range).

$$Ratio\% = \frac{P_{flow}}{Net_{flow}} \times 100$$

During delivery the ratio setpoint is modified to cater for the flush volume:

$$SP_{ratio(mod.)} = P_{ratio} \cdot \frac{Preset}{Preset - Flush}$$

## 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 1000 transactions with time and date stamps.

## Main Menu Variables

Main Menu Variables	Default Units	Variable Type
Net Volume	L	Total
Net Flowrate	L/min	Rate
Main Line Volume	L	Total
Main Line Flowrate	L/min	Rate
Process Line Volume	L	Total
Process Line Flowrate	L/min	Rate
Volumetric Ratio	%	Rate
Flowrate Ratio	%	Rate
Flowrate Deviation	L/min	Rate

Refer to [Available Units of Measurement](#) on page 74 for the list of available units.

## Communications

There are currently two communication ports available as follows:

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

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

## Isolated Outputs

The opto-isolated outputs can re-transmit any main menu variable. Totals are output as pulses and rates are output as 4-20mA signals. Alternatively, the outputs can be configured to provide application specific digital signals like flow error, pump demand, etc.

## Relay Outputs

The relay outputs 3 and 4 control the blending flow via a digital control valve. The relay output 2 provides a pump demand contact and the relay 1 can be used as a fully programmable alarm for any rate type variable.

## 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.

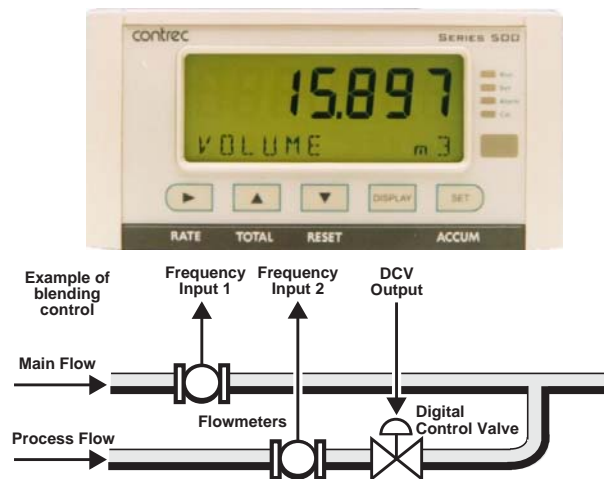


Figure 1 Typical Application Diagram

## Approvals

This instrument conforms to the EMC-Directive of the Council of European Communities 2014/30/EU, the LVD safety directive 2014/35/EU and the following standards:

- *EN61326:2013* Electrical equipment for measurement, control and laboratory use – EMC requirements: Industrial Environment.
- *EN61010:2010* Safety requirements for electrical equipment for measurement, control, and laboratory use.

In order to comply with these standards, the wiring instructions in [Chapter 3 - Installation](#) must be followed.

## FCC Declaration

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, might cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

Properly shielded and grounded cables and connectors must be used in order to meet FCC emission limits. Contrec Ltd is not responsible for any radio or television interference caused by using other than recommended cables and connectors or by unauthorized changes or modifications to this equipment. Unauthorized changes or modifications could void the user's authority to operate the equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device might not cause harmful interference, and (2) this device must accept any interference received, including interference that might cause undesired operation.





# Chapter 2

## Specifications

### Specification Table

<p><b>Operating Environment</b></p> <p><b>Temperature</b> -20°C to +60°C (conformal coating) +5°C to +40°C (no coating)</p> <p><b>Humidity</b> 0 to 95% non condensing (conformal coating) 5% to 85% non condensing (no coating)</p> <p><b>Power Supply</b> 100-240 V AC (+/-10%) 50-60 Hz (+/-10%) or 12-28 V DC</p> <p><b>Consumption</b> 6W (typical)</p> <p><b>Protection</b> Sealed to IP65 (Nema 4X) when panel mounted</p> <p><b>Dimensions (panel option)</b> 147mm (5.8") width 74mm (2.9") height 167mm (6.6") depth</p>	<p><b>Frequency Input (General)</b></p> <p><b>Range</b> 0 to 10kHz</p> <p><b>Overvoltage</b> 30V maximum</p> <p><b>Update Time</b> 0.3 sec</p> <p><b>Cutoff frequency</b> Programmable</p> <p><b>Configuration</b> Pulse, coil or NPS input</p> <p><b>Non-linearity</b> Up to 10 correction points</p>
<p><b>Display</b></p> <p><b>Type</b> Backlit LCD with 7-digit numeric display and 11-character alphanumeric display</p> <p><b>Digits</b> 15.5mm (0.6") high</p> <p><b>Characters</b> 6mm (0.24") high</p> <p><b>LCD Backup</b> Last data visible for 15min after power down</p> <p><b>Update Rate</b> 0.3 second</p>	<p><b>Pulse</b></p> <p><b>Signal Type</b> CMOS, TTL, open collector, reed switch</p> <p><b>Threshold</b> 1.3 volts</p>
<p><b>Non-volatile Memory</b></p> <p><b>Retention</b> &gt; 30 years</p> <p><b>Data Stored</b> Setup, Totals and Logs</p>	<p><b>Coil</b></p> <p><b>Signal Type</b> Turbine and sine wave</p> <p><b>Sensitivity</b> 15mV p-p minimum</p>
<p><b>Approvals</b></p> <p><b>Interference</b> CE compliance</p> <p><b>Enclosure</b> IECEx, ATEX and CSA approved enclosures available for hazardous areas</p>	<p><b>NPS</b></p> <p><b>Signal Type</b> NPS sensor to Namur standard</p>
<p><b>Real Time Clock (Optional)</b></p> <p><b>Battery Type</b> 3 volts Lithium button cell (CR2032)</p> <p><b>Battery Life</b> 5 years (typical)</p>	<p><b>Logic Inputs</b></p> <p><b>Signal Type</b> CMOS, TTL, open collector, reed switch</p> <p><b>Overvoltage</b> 30V maximum</p>
	<p><b>Relay Output</b></p> <p><b>No. of Outputs</b> 2 mechanical relays plus 2 solid state relays</p> <p><b>Voltage</b> 250 volts AC, 30 volts DC maximum (solid state relays use AC only)</p> <p><b>Current</b> 3A maximum</p>
	<p><b>Communication Ports</b></p> <p><b>Ports</b> RS-232 port RS-485 port (optional)</p> <p><b>Baud Rate</b> 2400 to 19200 baud</p> <p><b>Parity</b> Odd, even or none</p> <p><b>Stop Bits</b> 1 or 2</p> <p><b>Data Bits</b> 8</p> <p><b>Protocols</b> ASCII, Modbus RTU, Printer*</p>

### Transducer Supply

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

### Isolated Output

<b>No. of Outputs</b>	2 configurable outputs
<b>Configuration</b>	Pulse/Digital or 4-20mA output

### Pulse/Digital Output

<b>Signal Type</b>	Open collector
<b>Switching</b>	200mA, 30 volts DC maximum
<b>Saturation</b>	0.8 volts maximum
<b>Pulse Width</b>	Programmable: 10, 20, 50, 100, 200 or 500ms

### 4-20mA Output

<b>Supply</b>	9 to 30 volts DC external
<b>Resolution</b>	0.05% full scale
<b>Accuracy</b>	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

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### 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 139mm wide by 67mm high. Two side clips secure the unit into the panel.

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

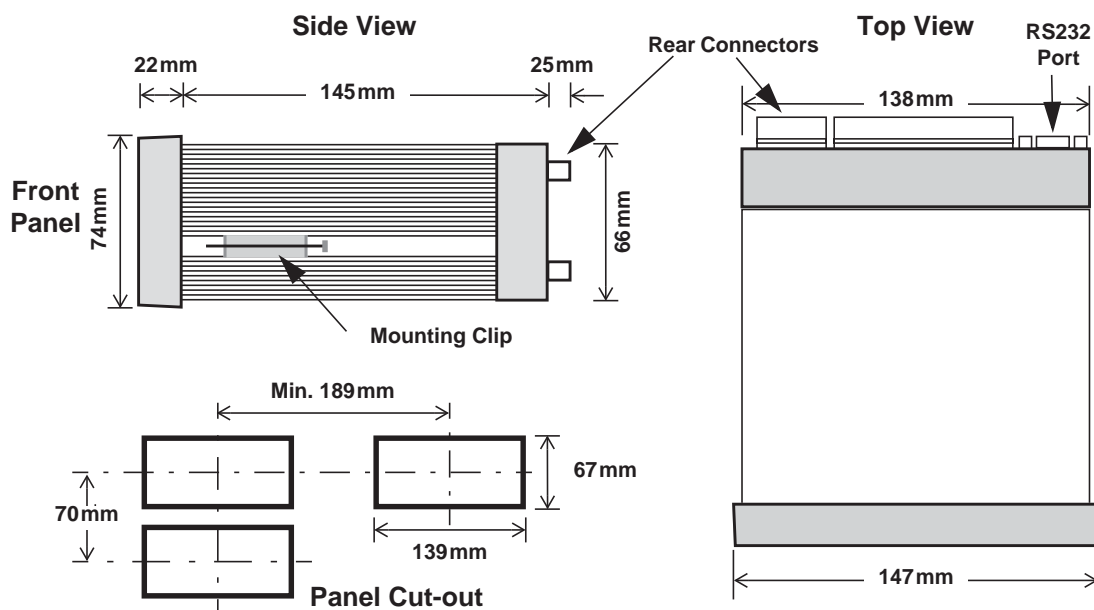


Figure 2 500 Series Instrument Panel Mounting

# Electrical Connection

## Rear Panel Connections

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

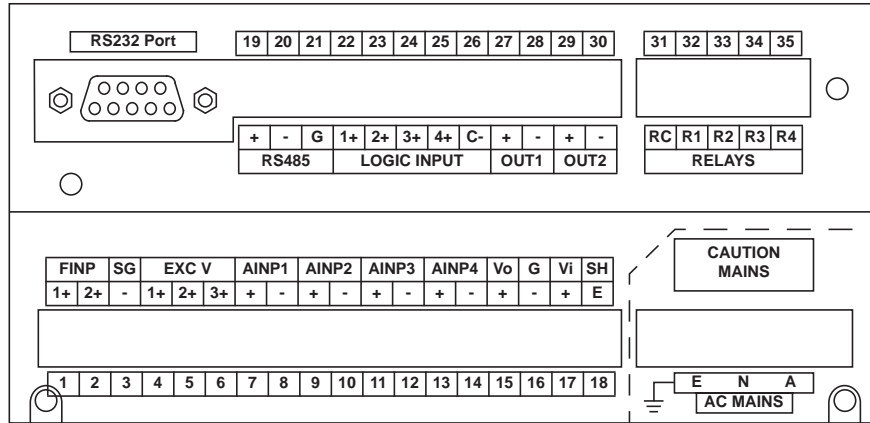


Figure 3 Rear Panel Connections

## Terminal Designations

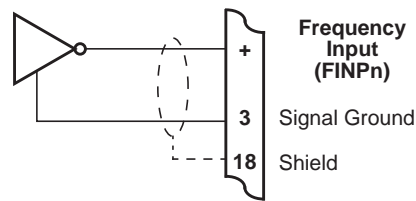
Terminal Label	Designation	Comment	Terminal Label	Designation	Comment
1	FINP 1+	Frequency Input 1+	19	RS485 +	RS485 (+)
2	FINP 2+	Frequency Input 2+	20	RS485 -	RS485 (-)
3	SG -	Signal ground	21	RS485 G	RS485 ground
4	EXC V 1+	Excitation Term 1+	22	LOGIC INPUTS 1+	Switch 1
5	EXC V 2+	Excitation Term 2+	23	LOGIC INPUTS 2+	Switch 2
6	EXC V 3+	Excitation Term 3+	24	LOGIC INPUTS 3+	Switch 3
7	AINP1 +	Analog Input ch 1 (+)	25	LOGIC INPUTS 4+	Switch 4
8	AINP1 -	Analog Input ch 1 (-)	26	LOGIC INPUTS C-	Signal ground
9	AINP2 +	Analog Input ch 2 (+)	27	OUT1 +	Output ch 1 (+)
10	AINP2 -	Analog Input ch 2 (-)	28	OUT1 -	Output ch 1 (-)
11	AINP3 +	Analog Input ch 3 (+)	29	OUT2 +	Output ch 2 (+)
12	AINP3 -	Analog Input ch 3 (-)	30	OUT2 -	Output ch 2 (-)
13	AINP4 +	Analog Input ch 4 (+)	31	RELAYS RC	Relay common
14	AINP4 -	Analog Input ch 4 (-)	32	RELAYS R1	Relay 1
15	Vo +	8-24 volts DC output	33	RELAYS R2	Relay 2
16	G -	DC Ground	34	RELAYS R3	Relay 3 (DCV Open)
17	Vi +	DC power input	35	RELAYS R4	Relay 4 (DCV Hold)
18	SH E	Shield terminal		RS232 port	9-pin serial port
E	AC MAINS E	Mains ground			
N	AC MAINS N	Mains neutral			
A	AC MAINS A	Mains active			

# Inputs

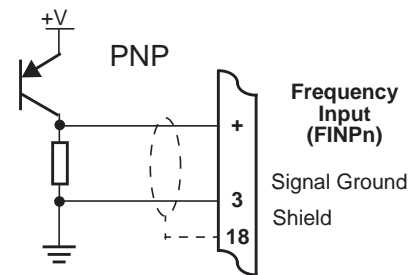
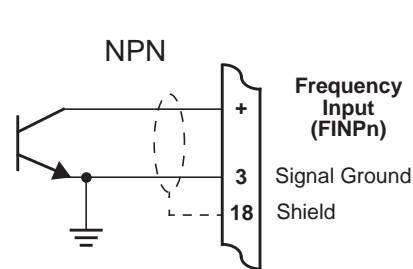
## Frequency Input Connection

Connect pulse or frequency input signals from devices such as: TTL, CMOS, open collector, reed relay switch, coil and Namur proximity switch, as shown below. For better signal integrity, it is recommended to use shielded cable. Refer to **Terminal Designations** on page 10 for specific terminal numbers for this application.

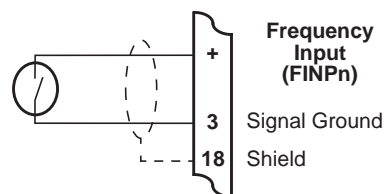
### Squarewave, CMOS or TTL



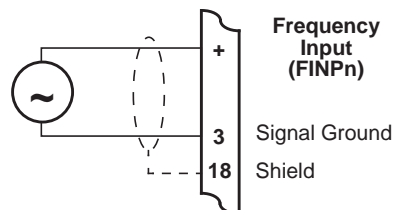
### Open Collector



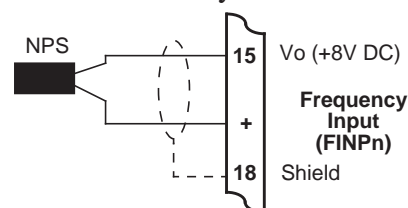
### Reed Relay Switch



### Coils - with 15 millivolts peak to peak AC minimum



### Namur Proximity Switch



## Logic Input Connection

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

It is possible to read the status of all the logic inputs via a Modbus register even if they are not used for a control purpose in the application.

A remote push-button key can be connected to the Logic Inputs as shown below.

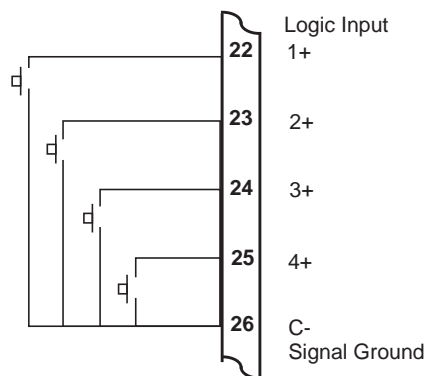


Figure 4 Logic Inputs Connection Diagram

## Outputs

The advanced option for the instrument provides two opto-isolated output ports. Either or both can be used for 4-20mA or pulse outputs.

### CAUTION

Due to the dual-purpose nature of the outputs, take care not to set the output as an open collector pulse type signal when connected to a 4-20mA loop circuit.

## 4-20mA Output Connection

Figure 5 shows the connections for a 4-20mA output. Output channel 1 uses terminals 27 (+) and 28 (-), output channel 2 uses terminals 29 (+) and 30 (-).

Maximum Load Resistance = (Supply - 9) / 0.02 ohms

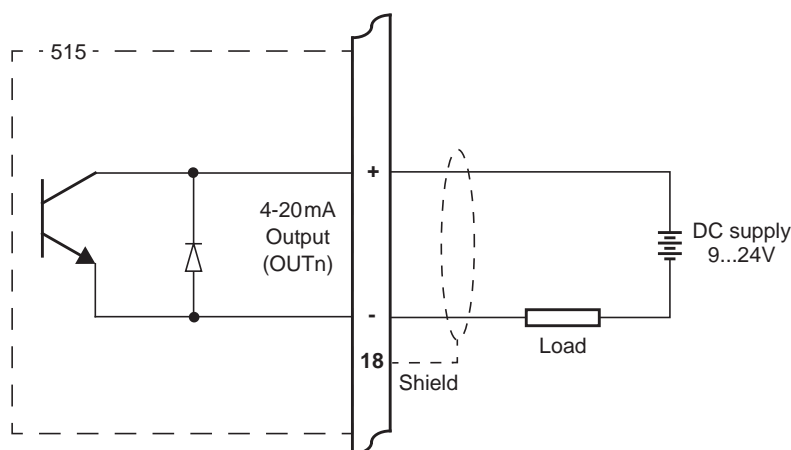


Figure 5 Output 4-20mA Connection Diagram

## Pulse Output Connection

Figure 6 shows a connection example for a pulse output. Output channel 1 uses terminals 27 (+) and 28 (-). Output channel 2 uses terminals 29 (+) and 30 (-).

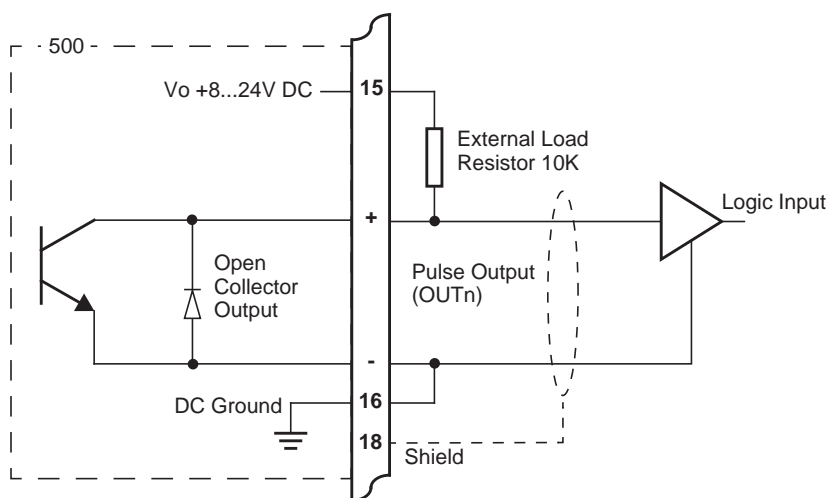


Figure 6 Output Pulse Connection Diagram

## Control Relays (Alarms)

The solid state relay outputs 3 and 4 provide DCV control. The relay output 2 provides a pump demand contact and the relay 1 can be used for alarms on any rate type variable.

The operation of alarm relay(s) can be set to various modes as described in [Alarms](#) on page 40.

There is also an equipment failure alarm option. This alarm can have normally closed (open) contacts which open (close) when the instrument displays any error message as listed in **Error Messages** on page 48, or if there is a loss of power to the instrument.

The output characteristics of the relays are:

- Maximum Voltage 250 volts AC
- Maximum Current 3 A

**Note:** Solid state relays use AC voltage only.

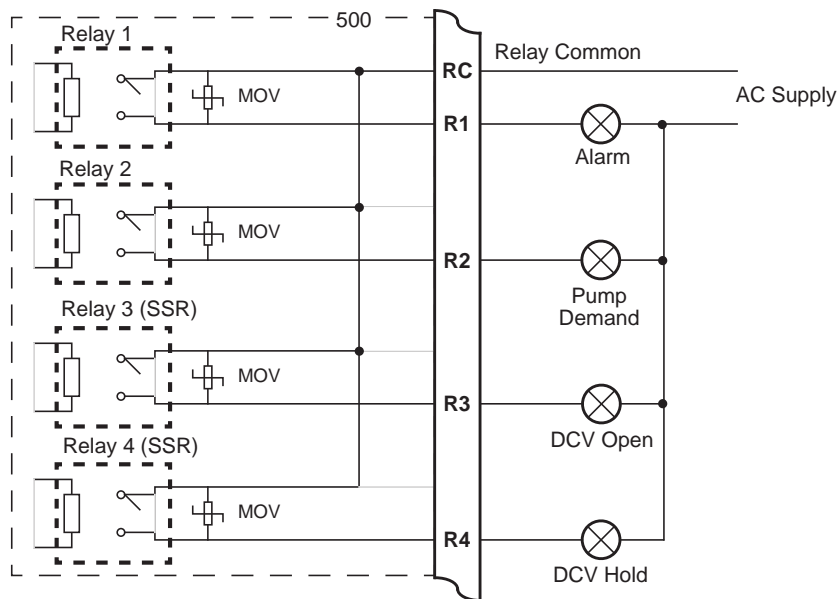


Figure 7 Relay Connection Diagram

## 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  $\mu\text{F}$  and 100  $\Omega$  will usually suffice. Note that only mains-approved RC suppression networks should be used.



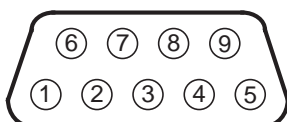
The basic principle of the operation is that the capacitor prevents a series of sparks arcing across the contact as the contact breaks. The series resistor limits the current through the contact when the contact first makes.

## Communications

The communication protocols are described in [Communications](#) on page 49.

### RS-232 Port

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



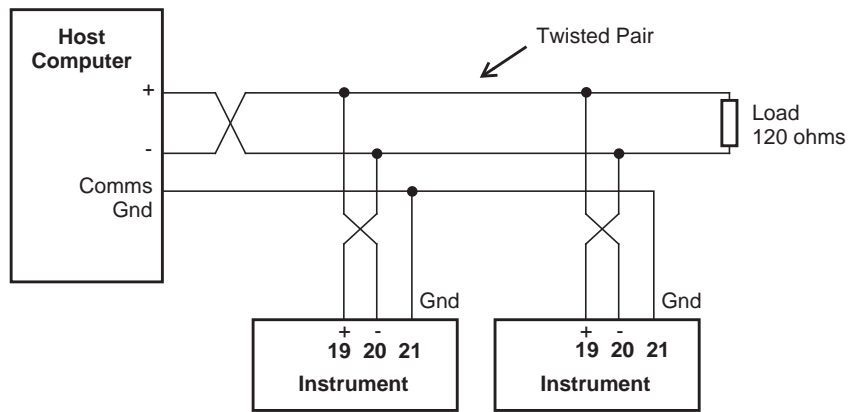
Pin 1	Not used
Pin 2	Transmit (TxD)
Pin 3	Receive (RxD)
Pin 4	Not used
Pin 5	Ground
Pin 6	Not used
Pin 7	Handshake line (CTS)
Pin 8	RTS Out
Pin 9	Not used

**Note:** The instrument does not require a null-modem cable for connection to a personal computer. Refer to [Hardware Interconnection](#) on page 49 for cable termination requirements.

### RS-485 Port (Optional)

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



*Figure 8 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

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### Normal Operation Mode

In normal operation mode, you press the buttons on the front panel to display the values recorded and calculated by the instrument. There are five categories of information that the instrument can display:

- Totals
- Rates
- Process variables
- Control setpoints
- Instrument settings

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

<b>Total</b>	<b>Rate</b>
Net Volume	Net Flowrate
Main Line Volume	Main Line Flowrate
Process Line Volume	Process Line Flowrate

### Default Variable & Total

In some applications, a particular variable or particular set of total and rate is of more interest than others, and for this reason a default variable and a default total (and its associated rate) can be assigned during instrument calibration. These defaults are used in the following ways:

- The default total (and rate) determines what comes first in the sequence of totals and rates that are displayed with the front panel keys.
- The default variable 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 LEDs

The status LEDs illuminate to show the following conditions:



- Run** Solid LED: delivery is in progress  
Flashing LED: delivery has reached the flushing stage
- Set** The instrument is in Calibrate Set mode.
- Alarm** The instrument has an error, as indicated on the display panel.
- Cal** The instrument is in Calibrate View mode.

## Front Panel Keys

For most actions with the front panel keys, you can hold a key to scroll through the values or options, instead of repeatedly pressing the key.

- RATE** Press the **RATE** key to display the rate that is associated with the currently displayed total. If an item other than a rate or total is displayed, press the **RATE** key to display the “default rate”. When a rate is displayed, press or hold the **RATE** key to display the other rate variables in turn.
- TOTAL** Press the **TOTAL** key to display the total that is associated with the currently displayed rate. If an item other than a rate or total is displayed, press the **TOTAL** key to display the “default total”. When a total is displayed, press or hold the **TOTAL** key to display the other total variables in turn.
- RESET** Use the **RESET** key to clear the totals when delivery is not in progress or to initiate a printout if the printer option has been selected. The printout is activated with a single press while the reset of the totals requires a press and hold for two seconds. The instrument generates 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.
- ACCUM** Hold the **ACCUM** key to display the accumulated value for the currently displayed total or to display the peak value for the currently displayed flowrate. See below for further details of peak flowrates.

## 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.

<b>DISPLAY</b> ↓	<b>Description</b>	<b>Options</b>
N-VOL	Net volume	Hold the <b>SET</b> key to display (or edit) the batch preset or briefly press to view the accum total
N-FLOW	Net flowrate	Hold the <b>ACCUM</b> key to display peak value

<div style="border: 1px solid black; padding: 2px; display: inline-block;">DISPLAY</div> ↓	Description	Options
M-VOL	Main line volume	Hold the <b>ACCUM</b> key to display accumulated total
M-FLOW	Main line flowrate	Hold the <b>ACCUM</b> key to display peak value
P-VOL	Process line volume	Hold the <b>ACCUM</b> key to display accumulated total
P-FLOW	Process line flowrate	Hold the <b>SET</b> key to display (or edit) the controlling setpoint
R-VOL	Process volumetric ratio	Hold the <b>SET</b> key to display (or edit) the controlling setpoint
R-FLOW	Process flowrate ratio	Hold the <b>SET</b> key to display (or edit) the controlling setpoint
DEVIAT	Process flowrate deviation	Hold the <b>SET</b> key to display (or edit) the controlling setpoint
REPORT PRINT	Only shown if print option is selected	Hold the <b>SET</b> 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 <b>SET</b> key to display data logs as described in <b>Data Logs</b> on page 20
MODEL INFO		Hold the <b>SET</b> key to display the Model information as described in <b>Model Information</b> on page 21
CAL MENU		Hold the <b>SET</b> key to enter Calibration View mode as described in <b>Calibration View Mode</b> on page 27

## Peak Flowrates

The peak value for the currently displayed flowrate can be viewed by holding the **ACCUM** key. The peak value is the average over a 15 minute period since the last reset of totals or powering on of the instrument. Dashes are shown for this value after a reset or power on until the first averaging period has passed.

## 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. 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.

## Setpoints

**SET** Hold the **SET** key to display (or edit) the controlling setpoint while viewing one of the process variables. The display of the setpoint 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 setpoint values are changed in exactly the same way as in calibration set mode.

## Data Logs

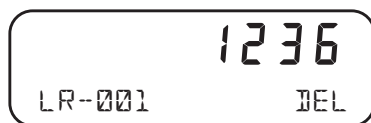
The instrument will log up to 1000 deliveries (batches) if the real-time clock option is installed. The logs are taken at the end of each batch or upon reset if a batch has been aborted before the preset total has been reached. Each entry has a log number, a delivery number and a time and date stamp. When the number of log entries exceeds 999 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  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  key use the  key to step through the stored information.
6. While holding the  key use the  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 2016. 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.

 ↓	<b>Description</b>
2-1--5- 515 MODEL	The hardware model code. Refer to <b>Product Codes</b> on page 71 for more information.
FF---- C001 INPUT	The Application number and the assignment of the inputs. Refer to <b>Application Information Code</b> on page 72 for more information.
3.0.000 500PM VERS	The version of 500-Series Program Manager from which the application software was compiled.

<div style="border: 1px solid black; padding: 2px; display: inline-block;">DISPLAY</div> ↓	Description
026357 CUSTOM VERS	The Customer version code for this installation. Refer to <b>Custom Version Codes</b> on page 72 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. The default unit tag is UNIT-1.
16-15 EDITED 27/08 2016	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 2016. 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.

## Blending Operation

This instrument provides blending functionality when operating together with an external batch controller (preset). The blending (process) line flow is controlled via a digital control valve (DCV) connected to the two solid state relay outputs. During delivery, the blending flow is controlled as the ratio of the net (combined) flow. If a clean start is required, the batch flush amount can be programmed and the instrument will modify the target ratio setpoint to allow for the main line flush amount at the end of the delivery:

$$SP_{ratio(mod.)} = SP_{ratio} \cdot \frac{Preset}{Preset - Flush}$$

The DCV and pump demand relays are de-activated when the delivered amount reaches the batch preset amount minus the flush amount or when delivery is stopped.

The instrument can operate in the following modes:

- PRESET
- ON-OFF
- RELEASE (only available in calibration set mode)



In the PRESET mode, the remote PERMISSIVE input (Logic Input 1) or Modbus RTU command is used to control the delivery's state (non-idle Modbus commands override the remote input). The delivery is registered as started when PERMISSIVE input is activated (or Modbus RUN command is received). The delivery is registered as finished when PERMISSIVE input is deactivated (or Modbus STOP command is received). The delivery logging occurs when the net flow actually stops.

In the ON-OFF (manual) mode the presence of the actual flow is used to determine the delivery's state. The delivery is registered as started when the net flow starts, and the delivery is finished and logged when the net flow stops. In this mode the Logic Input 1 inhibits the blending (process) line flow if de-activated (open circuit).

The RELEASE mode is only accessed from within the calibration mode and allows the operator to view the concise list of key parameters and gain immediate feedback for easier DCV control loop tuning. The control and tuning of the process line in this mode is independent of the main flow (deliveries are not registered in this mode). The optimal control can be achieved by adjusting the deadband and control factor parameters at the specified flowrate. The control factor allows the system response to be fine tuned by scaling the control signal (lower values will slow down the DCV operation).

## ON-OFF Mode of Operation

In ON-OFF mode a new batch is commenced when the net flow starts. The delivery is finalized and logged when the net flow stops.

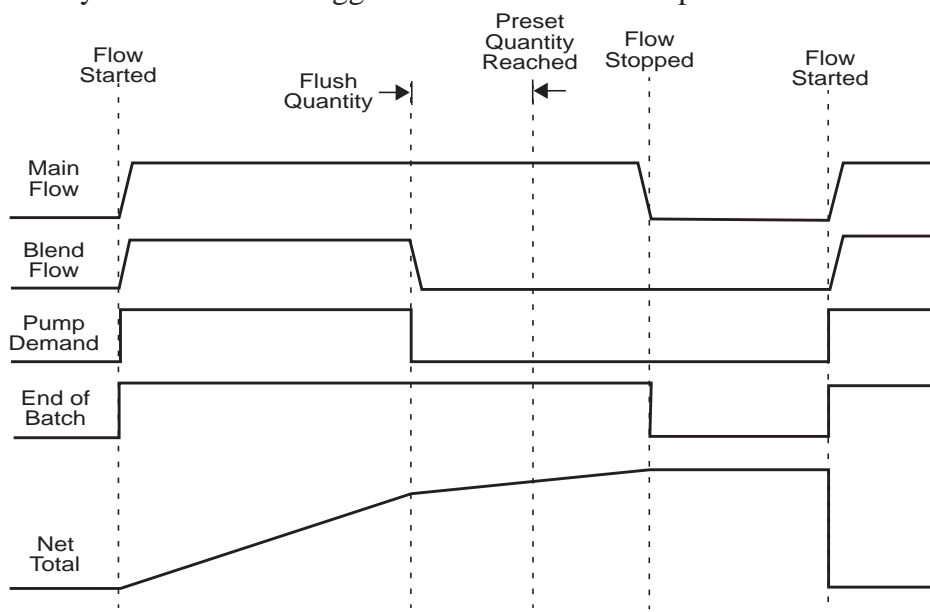


Figure 9 Blending Operation in ON-OFF Mode

## PRESET Mode of Operation

In PRESET mode a new batch is commenced when PERMISSIVE is activated either via a permissive input or Modbus RTU command. The delivery is finalized and logged when the net flow stops and either batch preset quantity is reached or PERMISSIVE is removed.

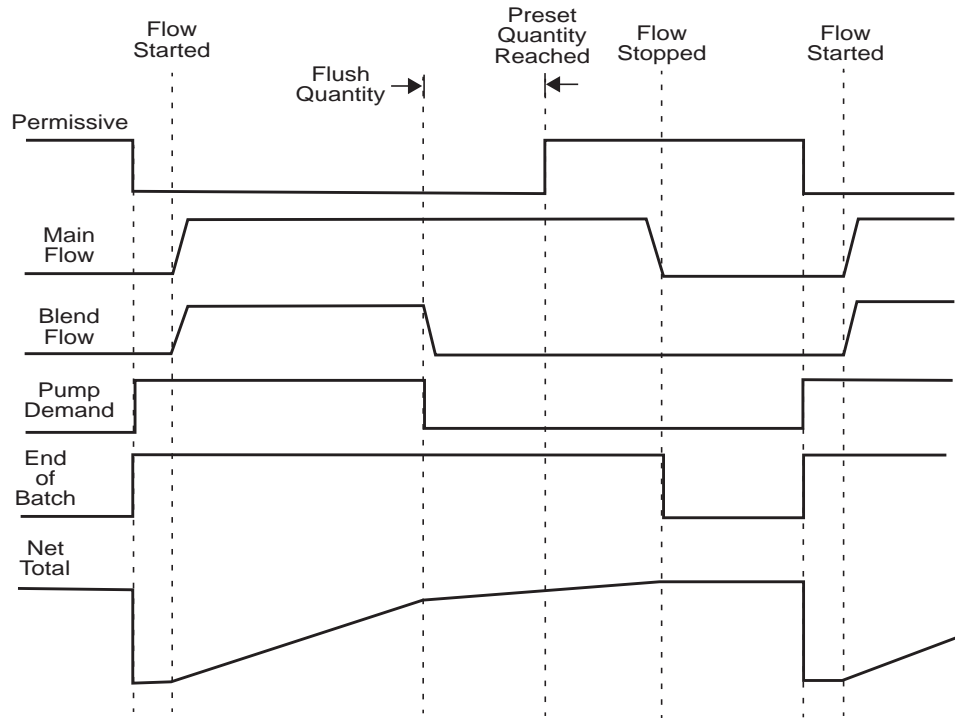
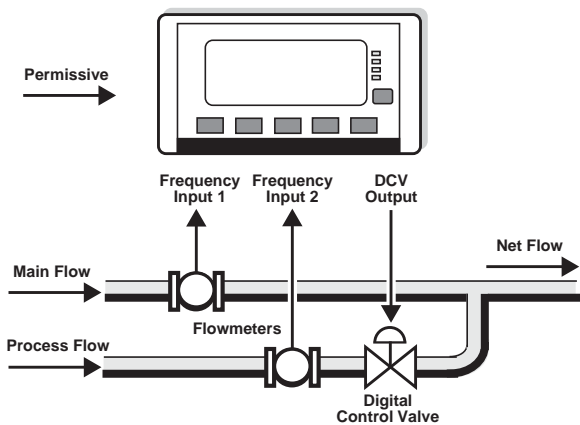


Figure 10 Blending Operation in PRESET Mode

## Typical Blending Configurations

### Blend Point After the Main Line Meter



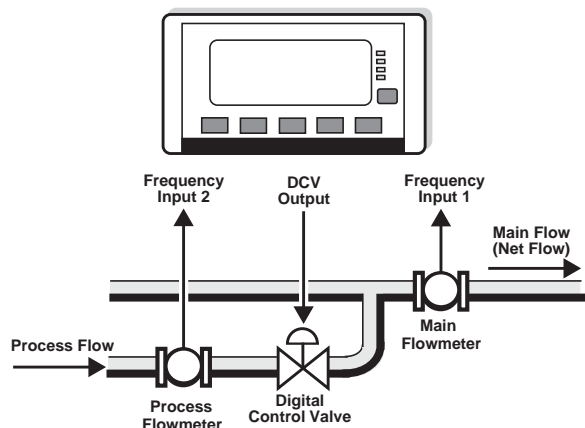
The desired blending ratio set point (RATIO %) is set via the front panel or serial communications.

The two solid state relays are used to maintain the desired process flowrate by controlling the digital control valve.

The desired process flow is determined as a ratio of the net (combined) flow (0 to 80% range). i.e.

$$Ratio\% = \frac{P_{flow}}{M_{flow} + P_{flow}} \times 100$$

### Blend Point Before the Main Line Meter



The desired blending ratio set point (RATIO %) is set via the front panel or serial communications.

The two solid state relays are used to maintain the desired process flowrate by controlling the digital control valve.

The desired process flow is determined as a ratio of the main (net) flow (0 to 80% range). i.e.

$$Ratio\% = \frac{P_{flow}}{M_{flow}} \times 100$$

### Resetting Totals

The instrument totals are reset by different means:

- At the end of a delivery, you can press the **RESET** key to reset the totals.
- Totals will automatically reset when the next delivery starts.

### Logic Input Control

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

- Logic Input 1 - Permissive

For connection details, refer to [Logic Input Connection](#) on page 12.

### Instrument Configuration Parameters on page 62 Digital Control Valve Connection

This instrument provides two solid state relay outputs to operate a DCV for blending line control. The relay 4 should be connected to the HOLD valve solenoid (usually normally open) and the relay 3 should be connected to the OPENING valve solenoid (usually normally closed).

**IMPORTANT:** Only AC power should be used for these outputs.

## Blending 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 with no delivery in progress.

The point at which these errors are detected is dependent on the values programmed into the calibration parameters FLOW TIMEOUT and ACCEPTABLE TOTAL. The open collector outputs can be assigned to activate when one of the flow errors occurs. Refer to [Instrument Settings](#) on page 32 for more details.

# Chapter 5

## Instrument Calibration

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### 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 **CFM MENU** prompt.
2. Hold the **SET** key.



The instrument beeps once, illuminates the **Cal** indicator and shows **CFM** 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 **FL MENU** prompt.
2. Hold the **SET** key.



The instrument beeps once, illuminates the **Cal** indicator and shows **FL** 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.



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.



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

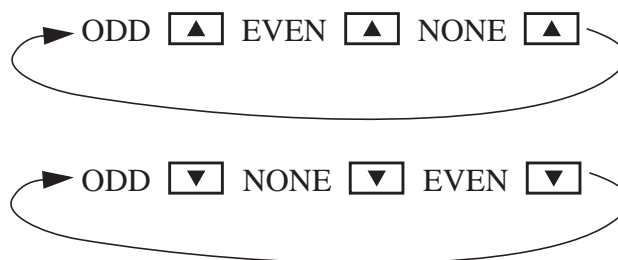
## Changing the Instrument Settings

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 be viewed in the UNITS menu in calibration below.

# Calibration Menu Tree

Figure 11 and Figure 12 show the keys for moving around the calibration menu tree in Calibration View or Set mode.

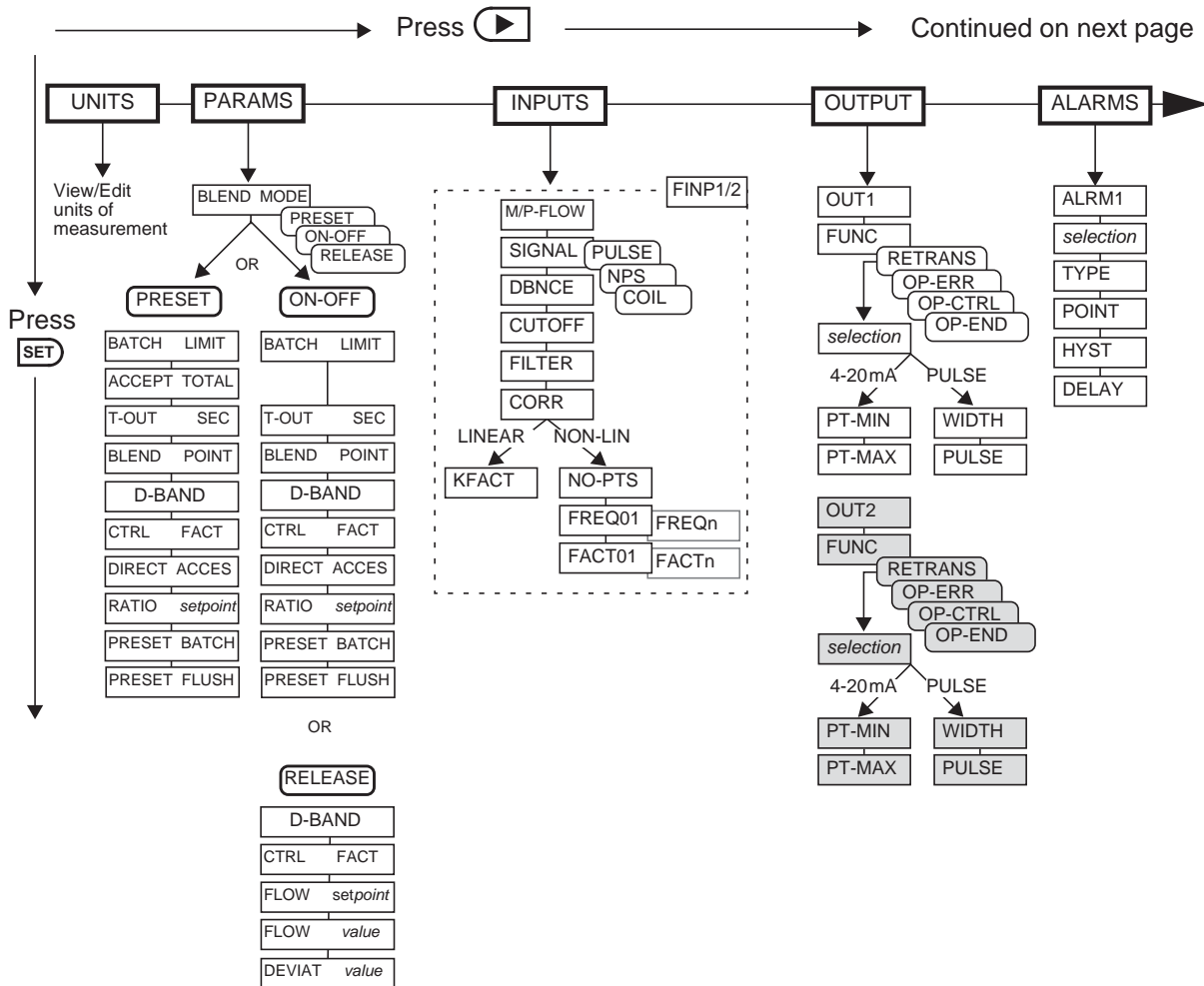
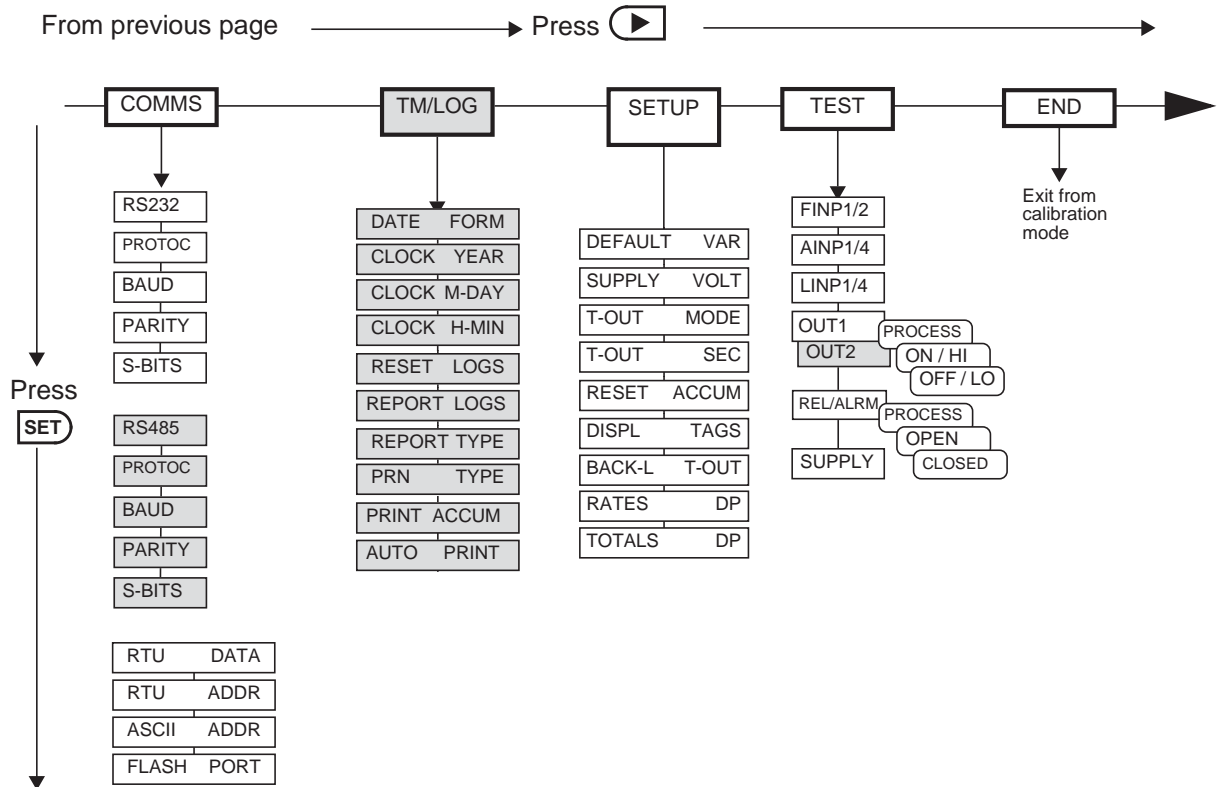


Figure 11 Calibration Menu Tree Sheet 1





 The shaded boxes indicate hardware options

Press  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 12 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.





<p><b>SET</b> ↓</p>	<p>▶ → <b>UNITS</b>   PARAMS   INPUTS   OUTPUTS   ALARMS   COMMS   TM/LOG   SETUP   TEST   END</p>
<p>ITEM <i>n</i>      <i>unit</i></p>	<p>The units for main menu or calibration items can be viewed by pressing the <b>SET</b> key.</p> <p>The units of measurement are password protected. To edit the units the correct password must be entered on entry to EDIT mode.</p> <p>Press ▲ or ▼ to select the required units. Refer to <b>Available Units of Measurement</b> on page 74 for the list of available units.</p>
<p>ACCEPT   UNITS</p>	<p>The Accept Units prompt will only appear if one or more of the units have been changed.</p> <p><b>IMPORTANT:</b> 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.</p> <p>Press ▲ or ▼ to select YES, then press the <b>SET</b> key. The instrument makes three beeps to confirm the reset command.</p> <p>The message -RESET- PLEASE WAIT will be displayed as the instrument exits calibration mode and completes a full re-boot sequence.</p>

## Parameters

SET ↓	▶ → UNITS <b>PARAMS</b> INPUTS OUTPUTS ALARMS COMMS TM/LOG SETUP TEST END
BLEND MODE	<p>Select the required blend operation mode.</p> <ul style="list-style-type: none"> <li>• <b>PRESET</b> - delivery controlled by logic input or Modbus RTU.</li> <li>• <b>ON-OFF</b> - delivery controlled by flow presence.</li> <li>• <b>RELEASE</b> - release flow (loop tuning, only available in calibration mode).</li> </ul> <p>Press <input type="button" value="▲"/> or <input type="button" value="▼"/> to select either: PRESET, ON-OFF, or RELEASE.</p> <p>Refer to the section <b>Blending Operation</b> on page 22 for descriptions of each mode.</p>
<p><b>Note:</b> The items actually shown in the PARAMS menu are dependent on the BLEND MODE chosen above. Items that are not relevant for that mode will not appear. Use the Calibration Menu Tree as a guide to the relevant items.</p>	
BATCH LIMIT	<p>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.</p>
ACCEPT TOTAL	<p>The 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.</p>
T-OUT SEC	<p>The flow timeout determines the length of no flow time that the instrument will wait during a delivery 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.</p> <p>Enter the value in seconds.</p>
BLEND POINT	<p>Blend point location:</p> <p>AFTER: after main line meter</p> <p>BEFORE: before main line meter</p>
DEADBAND Units	<p>The control deadband can be programmed to prevent the output continuously changing and thereby reducing wear on valves and actuators.</p> <p>While the main menu Deviation (error) is within the deadband, the process control signal will remain steady (i.e. the error is treated as zero in the algorithm).</p>

 ↓		 → UNITS <b>PARAMS</b> INPUTS OUTPUTS ALARMS COMMS TM/LOG SETUP TEST END
CTRL	FACT	The control scaling factor allows fine tuning of the system response by scaling the control signal. Set the factor to lower values to slow down the valve operation.
P-FLOW	SP	Loop/Process flowrate setpoint. This setpoint is only available in RELEASE (tuning) operation mode.
DIRECT	ACCES	If the direct access is enabled, the operator is able to enter edit mode for some parameters directly from the main menu by holding the  key (see <a href="#">Main Menu Items</a> on page 18 for more details). If disabled, these parameters can only be changed from within the calibration set mode or via Modbus RTU serial communication.  Press  or  to select ENABLE or DISABLE.
<b>Modbus Accessible Parameters</b>		
The following PARAMS menu item is also accessible via Modbus communications. For Modbus register listing, refer to <a href="#">Instrument Configuration Parameters</a> on page 62.		
RATIO	SP	Loop/Process ratio setpoint.
PRESET	BATCH	Enter the batch preset quantity in the engineering units of the Net Volume variable.
PRESET	FLUSH	The batch flush quantity can be set to allow for the clean product run at the end of the batch.  Enter the value in the engineering units of the Net Volume variable.

## Inputs

 ↓		 → UNITS PARAMS <b>INPUTS</b> OUTPUTS ALARMS COMMS TM/LOG SETUP TEST END
<b>Frequency Input 1 &amp; 2</b>		
<b>INPUT</b> M_FLOW FINP1 P-FLOW FINP2		Frequency Input Channels 1 and 2 are assigned as volumetric flow inputs. Channel 1 is for measuring the main line flow and channel 2 is for the process line flow.
SIGNAL FINP1 FINP2		Frequency input signal type.  Press  or  to select COIL, NPS or PULSE.

<input type="button" value="SET"/> ↓	<input type="button" value="▶"/> → UNITS PARAMS <b>INPUTS</b> OUTPUTS ALARMS COMMS TM/LOG SETUP TEST END
BOUNCE    FINP1 FINP2	<p>Switches and relays have metal contacts to make and break circuits. The contact bounce introduces random signals into the circuit. The instrument has a debounce circuit to eliminate this problem.</p> <p><b>Note:</b> When the debounce circuit is enabled, the maximum input frequency for large amplitude signals is limited to approximately 500Hz. For low amplitude signals, the maximum frequency can be approximately 200Hz.</p> <p>Press <input type="button" value="▲"/> or <input type="button" value="▼"/> to select ENABLE or DISABLE.</p>
CUTOFF    FINP1 FINP2	<p>The Cut-off is the lowest frequency for which the instrument continues to calculate a rate from the flowmeter.</p> <p>The value for the cut-off is specified as the frequency of the flowmeter in Hertz.</p> <p>Be careful when setting low cut-off values because the display update time for the flow rate becomes very long. For example, if the cut-off is set to 0.01Hz and the measured flow stops, the instrument continues to display the flow rate for 100 seconds before it can determine that the flow has actually stopped.</p>

<span style="border: 1px solid black; border-radius: 50%; padding: 2px;">SET</span> ↓		<span style="border: 1px solid black; border-radius: 50%; padding: 2px;">▶</span> → UNITS PARAMS <b>INPUTS</b> OUTPUTS ALARMS COMMS TM/LOG SETUP TEST END																																														
FILTER    FINP1 FINP2	<p>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.</p> <p>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.</p> <p>The value A is the filter constant that the user can set.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 33%;">Filter setting A</th> <th style="width: 33%;">Seconds to reach 90% of full swing</th> <th style="width: 33%;">Seconds to reach 99% of full swing</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>The input filter range is from 0 to 99. A setting of 0 (zero) means that there is no filtering.</p>			Filter setting A	Seconds to reach 90% of full swing	Seconds to reach 99% of full swing	0	0	0	2	2	4	4	4	8	6	5	10	10	8	15	15	12	23	20	14	27	25	18	34	35	25	48	45	32	62	60	42	82	75	52	102	90	62	122	99	68	134
Filter setting A	Seconds to reach 90% of full swing	Seconds to reach 99% of full swing																																														
0	0	0																																														
2	2	4																																														
4	4	8																																														
6	5	10																																														
10	8	15																																														
15	12	23																																														
20	14	27																																														
25	18	34																																														
35	25	48																																														
45	32	62																																														
60	42	82																																														
75	52	102																																														
90	62	122																																														
99	68	134																																														
CORR      FINP1 FINP2	<p>If the input sensor has non-linear characteristics, select NON-LINEAR to apply correction factors to the input signal.</p> <p>Use <span style="border: 1px solid black; padding: 0 2px;">▲</span> or <span style="border: 1px solid black; padding: 0 2px;">▼</span> to select LINEAR or NON-LINEAR.</p>																																															
KFACT1 <i>unit</i> KFACT2 <i>unit</i>	<p><i>This parameter is available for viewing and editing only when the correction type is set to Linear.</i></p> <p>The K-factor of the flowmeter is the number of pulses from the flowmeter per unit of volume. The K-factor cannot be 0 (zero).</p>																																															

<div style="display: inline-block; border: 1px solid black; padding: 2px;">SET</div> ↓		<div style="display: inline-block; border: 1px solid black; padding: 2px;">▶</div> → UNITS PARAMS <b>INPUTS</b> OUTPUTS ALARMS COMMS TM/LOG SETUP TEST END
NO-PTS FINP1 FINP2		<p><i>This parameter is available for viewing and editing only when the correction type is set to Non-linear.</i></p> <p>Enter the number of non-linearity correction points.</p> <p>Press <div style="border: 1px solid black; padding: 0 2px;">▲</div> or <div style="border: 1px solid black; padding: 0 2px;">▼</div> to select a number between 1 and 10 for the number of correction points.</p>
FREQ01 to FREQ <sub>n</sub>	FINP1	<p><i>This parameter is available for viewing and editing only when the correction type is set to Non-linear.</i></p> <p>Enter the frequency for this correction point.</p> <p>The instrument uses linear interpolation between the correction points except that the correction factor for FREQ01 is used from 0Hz up to FREQ01. Similarly, the instrument maintains the correction factor for the highest frequency setting up to the maximum input frequency.</p> <p>The following diagram shows the scaling factors at different frequencies for a hypothetical flowmeter. The heavy black line represents the actual scaling factor of the flowmeter. The light black line is the approximation that the instrument uses.</p> <div style="text-align: center;"> </div> <p>Enter the lowest correction factor frequency as FREQ01 and proceed up to the highest frequency. You can press the <div style="border: 1px solid black; padding: 0 2px;">DISPLAY</div> key to skip the non-linear points and go to the next item.</p>
FACT01 to FACT <sub>n</sub>	FINP1	<p><i>This parameter is available for viewing and editing only when the correction type is set to Non-linear.</i></p>
FACT01 to FACT <sub>n</sub>	FINP2	<p>Enter the scaling factor for this correction point in the same units of measure as the single K-factor above.</p> <p>The correction factor cannot be 0 (zero).</p>

## Outputs

SET ↓	▶ → UNITS PARAMS INPUTS <b>OUTPUTS</b> ALARMS COMMS TM/LOG SETUP TEST END
FUNC      OUT <sub>n</sub>	<p>The 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.</p> <p>Press ▲ or ▼ to select RETRANS, OP-ERR, OP-CTRL or OP-END</p>
PULSE      OUT <sub>n</sub> or 4-20	<p>You can assign any of the “main menu” variables to an output. The nature of the output depends on the assigned variable. Totals are output as pulses and rates are output as 4-20mA passive signals.</p> <p>Press ▲ or ▼ to select the variable that is required as an output. The top of the display shows the type of output signal that is assigned to the variable.</p> <p style="text-align: center;"><b>CAUTION</b></p> <p style="text-align: center;">Due to the dual-purpose nature of the outputs, take care not to set the output as an open collector pulse type signal when connected to a 4-20mA loop circuit.</p>
WIDTH      OUT <sub>n</sub>	<p><i>The Output Pulse Width is available for viewing and editing only when the assigned variable is a total (pulse output) type.</i></p> <p>Pulse output is usually used to drive remote counters. Set the pulse width (in milliseconds) as required by the remote counter.</p> <p>Press ▲ or ▼ to set to: 10, 20, 50, 100, 200 or 500ms.</p>
PULSE      OUT <sub>n</sub>	<p><i>The Output Pulse Factor is available for viewing and editing only when the assigned variable is a total (pulse output) type.</i></p> <p>The Output Pulse Factor is the scaling factor for the retransmission of the measured total quantity.</p> <p>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<sup>3</sup>. Similarly, a pulse factor of 3.000 generates one pulse for 3 m<sup>3</sup>.</p> <p>For more information, see <b>Output Pulse Factor</b> on page 39.</p> <p>The output pulse factor cannot be 0 (zero).</p>



SET ↓	▶ → UNITS PARAMS INPUTS <b>OUTPUTS</b> ALARMS COMMS TM/LOG SETUP TEST END
PT--MIN    OUTn PT--MAX    OUTn	<p><i>The Output Minimum Point and Maximum Point are available for viewing and editing only when the assigned variable is a rate (4-20mA output) type.</i></p> <p>The output minimum value corresponds to the 4mA point and the output maximum value corresponds to the 20mA point.</p> <p>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.</p> <p>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 100m<sup>3</sup>/min. At rates above the maximum and below the minimum points, the output remains at 20mA and 4mA respectively.</p>

### 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 50ms:

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

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

## Alarms



The alarm relay(s) can be assigned to rate variables such as flow rate, or set as an equipment failure alarm.

The alarm switches “on” whenever an alarm condition exists. The alarm switches “off” when the alarm condition no longer exists. However, you may need to configure external alarm devices that require acknowledgement for cancelling an alarm.

### Equipment Failure Alarm

Any alarm relay can be assigned as an equipment failure alarm. This alarm setting can have normally closed (open) contacts that open (close) when the instrument displays any error message as listed in [Error Messages](#) on page 48.

<span style="border: 1px solid black; border-radius: 50%; padding: 2px;">SET</span> ↓		<span style="border: 1px solid black; border-radius: 50%; padding: 2px;">▶</span> → UNITS PARAMS INPUTS OUTPUTS <b>ALARMS</b> COMMS TM/LOG SETUP TEST END
RELAY	ALRM <sub>n</sub>	<p>Select a rate variable to assign to the alarm relay.</p> <p><b>Note:</b> If the alarm type is set to “equipment alarm”, this relay assignment setting is ignored.</p> <p>Press <span style="border: 1px solid black; border-radius: 50%; padding: 2px;">▲</span> or <span style="border: 1px solid black; border-radius: 50%; padding: 2px;">▼</span> to select the variable that is required as an alarm.</p>
TYPE	ALRM <sub>n</sub>	<p>The options available for alarm types are as follows:</p> <ul style="list-style-type: none"> <li>• HI-NO - High Alarm, contacts are Normally Open</li> <li>• HI-NC - High Alarm, contacts are Normally Closed</li> <li>• LO-NO - Low Alarm, contacts are Normally Open</li> <li>• LO-NC - Low Alarm, contacts are Normally Closed</li> <li>• BD-NO - Band Alarm, contacts are Normally Open</li> <li>• BD-NC - Band Alarm, contacts are Normally Closed</li> <li>• AL-NO - Equipment Alarm, contacts are Normally Open</li> <li>• AL-NC - Equipment Alarm, contacts are Normally Closed</li> </ul> <p>Press <span style="border: 1px solid black; border-radius: 50%; padding: 2px;">▲</span> or <span style="border: 1px solid black; border-radius: 50%; padding: 2px;">▼</span> to select the type of alarm required.</p>
POINT	ALRM <sub>n</sub>	<p><i>The Alarm Setpoint is available for viewing and editing for any alarm type except ‘equipment alarms’.</i></p> <p>The Alarm Setpoint is the value (in engineering units of assigned variable) at which the alarm condition occurs and therefore the alarm is on.</p> <p>Each alarm is completely independent, e.g. a High alarm does NOT need to have a higher setpoint than the a Low alarm.</p>

 ↓		 → UNITS PARAMS INPUTS OUTPUTS <b>ALARMS</b> COMMS TM/LOG SETUP TEST END
HYST	ALRM <sub>n</sub>	<p><i>The Alarm Hysteresis is available for viewing and editing for any alarm type except 'equipment alarms'.</i></p> <p>Alarm hysteresis loops occur when the alarm toggles continuously on and off when the process variable is close to the setpoint.</p> <p>For a high alarm, the alarm activates when the value of the variable rises above the alarm setpoint and deactivates when the value falls below the alarm setpoint minus the amount of the hysteresis setting (if any).</p> <p>For a low alarm, the alarm activates when the value of the variable falls below the alarm setpoint and deactivates when the value rises above the alarm setpoint plus the amount of the hysteresis setting (if any).</p> <p>For a band alarm, the alarm activates whenever the value of the variable is outside the setpoint plus or minus the amount of the hysteresis.</p> <p>For example, with a high alarm setpoint of 200, and a hysteresis setting of zero, a value oscillating between 197 and 202 will cause the alarm to toggle on at 200 and toggle off below 200. However, if the hysteresis is set to 5, the value of the variable must fall below 195 to cancel the alarm. The alarm will reactivate only when the value again rises above 200.</p>
DELAY	ALRM <sub>n</sub>	<p>The Alarm Delay is programmed in seconds and can be used to eliminate undesired alarm activation during start-up or shutdown operation.</p>

## Communications

The instrument has the following communication ports:

- **RS-232 Port** - A 9-pin female connector on the rear panel of the instrument.
- **RS-485 Port** (optional) - Terminals on the rear panel.
- **Infra-red Port** - Discontinued - Although program settings may be visible in calibration, the required hardware is no longer available. The Infra-red protocol assignment (PROT<sub>00</sub> INFR<sub>00</sub>) should be set to NONE and the remaining INFR<sub>00</sub> settings can be ignored.

<input type="button" value="SET"/> ↓		<input type="button" value="▶"/> → UNITS PARAMS INPUTS OUTPUTS ALARMS <b>COMMS</b> TM/LOG SETUP TEST END
PROTOC    RS232 RS485 INFRA	<p>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):</p> <ul style="list-style-type: none"> <li>• <b>ASCII</b>    - Simple ASCII        available for all ports</li> <li>• <b>RTU</b>        - Modbus RTU        available for all ports</li> <li>• <b>PRN</b>        - Printer Protocol    available for RS232 and RS485</li> <li>• <b>NONE</b>      - If a port is not being used, set the protocol to NONE.</li> </ul> <p>Printer Protocol (PRN) is only available if the option with Real Time Clock is installed.</p> <p>For the selected port, press <input type="button" value="▲"/> or <input type="button" value="▼"/> to select the desired protocol.</p>	
BAUD        RS232 RS485 INFRA	<p>The Baud setting is the speed of the communication port in data bits per second.</p> <p>The baud rate of the instrument must match the baud rate of the communication device that the instrument is connected to.</p> <p>Use <input type="button" value="▲"/> or <input type="button" value="▼"/> to select 2400, 4800, 9600 or 19200 baud.</p>	
PARITY    RS232 RS485 INFRA	<p>The Parity bit helps to detect data corruption that might occur during transmission.</p> <p>The parity bit setting of the instrument must match the parity bit setting of the communication device that the instrument is connected to.</p> <p>Press <input type="button" value="▲"/> or <input type="button" value="▼"/> to select EVEN, ODD, or NONE.</p>	
S-BITS    RS232 RS485 INFRA	<p>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.</p> <p>Press <input type="button" value="▲"/> or <input type="button" value="▼"/> to select 1 or 2 stop bits.</p>	
RTU         DATA	<p>The Modbus RTU data format for the 2-register (4-byte) values can be set as either floating point or long integer values.</p> <p>Use <input type="button" value="▲"/> or <input type="button" value="▼"/> to select FLOAT or INTEGER.</p>	

<input type="button" value="SET"/> ↓		<input type="button" value="▶"/> → UNITS PARAMS INPUTS OUTPUTS ALARMS <b>COMMS</b> <small>TM/LOG SETUP TEST END</small>
RTU	ADDR	<p>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.</p> <p><b>Note:</b> The master device uses the RTU address 0 (zero) for broadcasting to all connected slave units.</p>
ASCII	ADDR	<p>The ASCII protocol address identifies each communicating device.</p> <p>The address must be in the range of 1 to 255. When multiple instruments (slaves) are connected to one computer (master), each assigned address must be unique.</p>
FLASH	PORT	<p>The Flash Driver Port assignment defines the communication port for downloading software into the instrument.</p> <p>The default setting of this assignment is the RS-232 port.</p> <p>Press <input type="button" value="▲"/> or <input type="button" value="▼"/> to select RS-232, RS-485, or INFRA.</p>

## 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 1000 deliveries (batches) if the real-time clock option is installed. The logs are taken at the end of each batch.

<b>SET</b> ↓		▶ → UNITS PARAMS INPUTS OUTPUTS ALARMS COMMS <b>TM/LOG</b> SETUP TEST END
DATE	FORM	<p>Clock Date Format</p> <p>The European date format is: dd/mm/yyyy or (Day-Month).</p> <p>The American date format is: mm/dd/yyyy or (Month-Day).</p> <p>Press <b>▲</b> or <b>▼</b> to select DAY-M or M-DAY</p>
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	<p>Reset the logged data. You may need to reset (clear) the logged data if you change the time/log settings.</p> <p>Press <b>▲</b> or <b>▼</b> to select YES, then press the <b>SET</b> key. The instrument makes three beeps to confirm the reset command.</p>
REPORT	LOGS	<p>The Printer Protocol Report Logs defines the number of latest logs to be included into a printable report.</p> <p>Enter the number of logs between 0 and 99.</p>
REPORT	TYPE	<p>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:</p> <ul style="list-style-type: none"> <li>• REP-10 Preset number of latest logs</li> </ul> <p>Press <b>▲</b> or <b>▼</b> to select Report Type.</p>
PRN	TYPE	<p>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:</p> <ul style="list-style-type: none"> <li>• PRN-01 Generic computer printer</li> <li>• PRN-02 Generic roll printer (prints first line first)</li> <li>• PRN-03 Slip printer TM295</li> <li>• PRN-04 Label (roll) printer - Citizen CMP30L</li> </ul> <p>Press <b>▲</b> or <b>▼</b> to select Printer Type.</p>

## General Setup Parameters

<div style="text-align: right;">SET ↓</div>	<div style="text-align: right;">▶ → UNITS PARAMS INPUTS OUTPUTS ALARMS COMMS TM/LOG <b>SETUP</b> TEST END</div>
DEFAULT TOTAL	<p>The instrument displays the default Total when the user presses the <b>TOTAL</b> key or when the timeout period has elapsed if it is enabled.</p> <p>Press ▲ or ▼ to select the default total display.</p>
SUPPLY VOLT	<p>The instrument provides a power-limited supply for external transducers.</p> <p>Press ▲ or ▼ to set the transducer supply voltage between 8 and 24 volts DC as required.</p>
T-OUT MODE	<p>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.</p> <p>This function is useful for the following reasons:</p> <ul style="list-style-type: none"> <li>• to return the display to a preferred variable after the user has finished reading other information,</li> <li>• to cancel the calibration mode and return to the default display if the user does not exit from the calibration mode for any reason.</li> </ul> <p>Press ▲ or ▼ to select the display timeout function as follows:</p> <ul style="list-style-type: none"> <li>• <b>DISABLE</b> - Timeout is completely disabled.</li> <li>• <b>EN DISP</b> - Timeout is enabled during Normal mode and Calibration View mode.</li> <li>• <b>EN EDIT</b> - Timeout is enabled during Calibration Set mode.</li> <li>• <b>EN ALL</b> - Timeout is enabled for all modes.</li> </ul>
T-OUT SEC	<p>The Display Timeout period defines the delay for the Display Timeout mode if it is enabled.</p> <p>The display timeout period can be from 10 to 99 seconds.</p>
RESET ACCUM	<p>The Reset Accumulated Totals function clears all of the accumulated totals and the non-accumulated totals.</p> <p>Press ▲ or ▼ to select YES, then press the SET key. The instrument makes three beeps to confirm the reset command.</p>

SET ↓	▶ → UNITS PARAMS INPUTS OUTPUTS ALARMS COMMS TM/LOG <b>SETUP</b> TEST END
DISPL TAGS	<p>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.</p> <p><b>Note:</b> The user-defined tags can be entered into the instrument only by the manufacturer or the distributor.</p> <p>Press ▲ or ▼ to select the Display Tags option as follows:</p> <ul style="list-style-type: none"> <li>• <b>DEFAULT</b> - the instrument displays the default (English) tags</li> <li>• <b>USER</b> - the instrument displays the user-defined tags.</li> </ul>
BACK-L T-OUT	<p>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.</p> <p>Press ▲ or ▼ to select ENABLE or DISABLE.</p>
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 OUTPUTS ALARMS COMMS TM/LOG SETUP <b>TEST</b> END
FINP <sub>n</sub> Hz	The frequency of the input to FINP <sub>n</sub> is displayed in Hertz.
AINP <sub>n</sub> Units	The units are displayed according to the calibration setup for the analog input. If unused or set to Default the input is 4-20mA and displayed in mA.
LINP <sub>n</sub> STATE	You can view the state of the logic inputs. If the input is an open contact or inactive it will display <b>HI</b> . If the input is a closed contact or active it will display <b>LO</b> .



SET ↓	▶ → UNITS PARAMS INPUTS OUTPUTS ALARMS COMMS TM/LOG SETUP <b>TEST</b> END
OUT <sub>n</sub> STATE	<p>You can control the state of the outputs. Press the ▲ or ▼ keys to set the output state as follows:</p> <ul style="list-style-type: none"> <li>• <b>PROCESS</b> - the output depends on the current values of the inputs and the calculations that the instrument performs.</li> </ul> <p>For a pulse output, such as a total, the output produces a pulse train as follows:</p> <ul style="list-style-type: none"> <li>• <b>ON</b> - a pulse train with a pulse width as set in the Outputs menu.</li> <li>• <b>OFF</b> - no output.</li> </ul> <p>For a 4-20mA output, such as a rate, the output is as follows:</p> <ul style="list-style-type: none"> <li>• <b>HI</b> - the output is set to 20mA.</li> <li>• <b>LO</b> - the output is set to 4mA.</li> </ul>
ALRM <sub>n</sub> STATE or REL -n	<p>You can control the state of the relays (alarms). Press the ▲ or ▼ keys to set the selected relay as follows:</p> <ul style="list-style-type: none"> <li>• <b>PROCESS</b> - the relay operates according to the current values of the inputs and the relay settings as programmed.</li> <li>• <b>OPEN</b> - the relay output contacts are set to “open”.</li> <li>• <b>CLOSED</b> - the relay output contacts are set to “closed”.</li> </ul>
SUPPLY ✓	<p>You can display the actual DC output supply voltage, which may help with troubleshooting.</p> <p>If the actual supply voltage is lower than the preset value (refer to <b>General Setup Parameters</b> on page 45) it may indicate that the output is overloaded.</p>

## 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 instrument 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.  <b>Note:</b> The instrument can continue operating with a failed battery, but the correct time will be lost if there are interruptions to the power supply.
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 attempting to stop the flow.
Leakage Detected	The “leakage” condition is detected when an amount greater than the acceptable total is received without starting a delivery.

## Warning Messages

The instrument 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.
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

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### 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 two communication ports:

- RS-232 port on the rear panel (DB9 female connector)
- RS-485 port on the rear panel (optional)

The appropriate interface and protocols are selected during calibration.

#### RS-232 Port

The RS-232 port provides communication between the instrument and another 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 13.

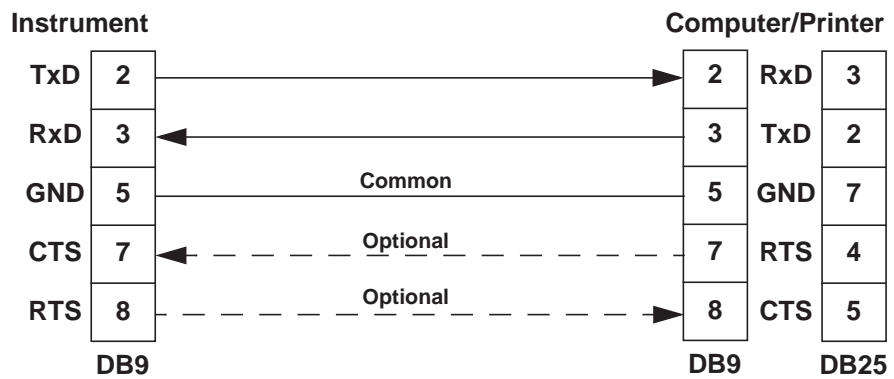


Figure 13 RS-232 Cable Connections to a Computer

**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 14. Up to 32 units can be connected to the interface at a maximum distance of 1200 metres.

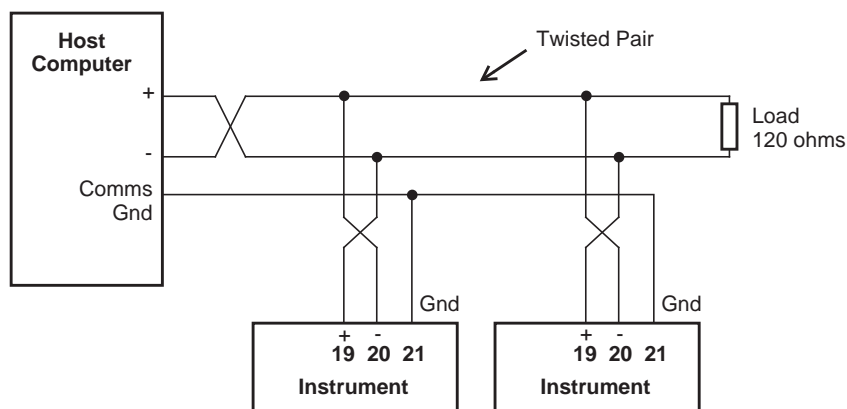


Figure 14 RS-485 Connections

### 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:

- **ASCII** - Simple ASCII available for all ports
- **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 41.

- **ASCII** - In this ASCII protocol each command and response is a string of ASCII characters. This proprietary protocol is developed by Contrec to allow for simple information interchange. The main advantages of this mode are that it allows extended time intervals to occur between characters without causing a timeout error and that messages can be sent and monitored easily with a simple ASCII terminal.
- **Modbus RTU** - Modbus RTU is an industry-standard protocol which allows the instrument to be easily connected to computers running supervisory software systems. The main advantage of this mode is that its greater character density allows better data throughput than ASCII mode, however each message must be transmitted in a continuous stream.
- **Printer** - In the Printer protocol there is a selection of printer types. Please refer to the **Printer Protocol** on page 63 for full details.

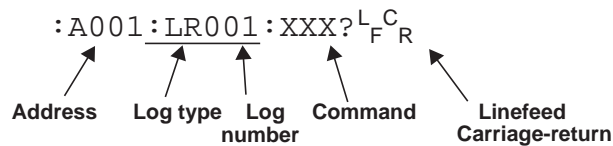
## Simple ASCII Protocol

This simple ASCII protocol requires that all requests are initiated with a colon (:) and terminated with a carriage return ( $C_R$ ). The message termination can include a linefeed before the carriage-return ( $L_F C_R$ ), but it is the carriage-return that acts as the message termination.

All responses by the instrument are terminated with a linefeed and a carriage-return ( $L_F C_R$ ).

## Requests Format

The format of a request to the instrument is as follows:



Each request must include the address and command portions. The underlined section is an optional part of the request string.

### Address

In multipoint communications, each instrument must have a unique address and it is essential in the request for identifying a particular instrument. However, it may be set to 000, for special broadcast commands.

For single-instrument communications, the address can also be set to 000 in the request.

Refer to **Communications** on page 41 for setting the instrument address.

**Note:** The instrument always responds with its address in the header regardless of the type of request.

### Log Type and Number

The log type and number enables a communicating device to retrieve data from the instrument. The data can be from the event-based logs or from the current process variables.

The log request is optional. If the log request is not included, or the log number is set to 000, the instrument returns the current process variables. If the log request is included, the log number defines the specific log entry by counting backwards. The most recent log entry for a timebase is 001.

The “last edit” log records the process variables at the time of the last exit from the calibration edit mode. There is only one “last edit” log, therefore, if a number is included in the request, the instrument ignores the number and returns the data at the time of the last edit.

The types of logs applicable to this instrument are as follows:

Log Type
LE - last edit log
LR - logged records (non-timebased logging)
LN - current totals displayed as Non-accumulated

The number of the log entry is the same as shown on the front panel of the instrument. For example, a request for LR003 would return the data for the log entry two batches prior to the most recent batch log entry.

## Instrument Responses

The instrument response time to any enquiry is no more than 300ms. The responses from the instrument are in the following format:

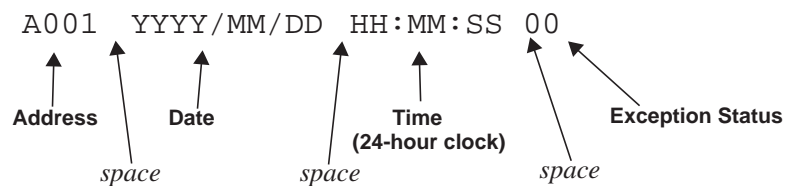
```

HEADERLFCR
DATALFCR
DATALFCR
.
.
.
DATALFCR
LFCR
    
```

The components of the response message are as follows:

### Header

The format of the response header from the instrument is as follows:



The instrument **Exception Status** codes that the instrument returns for the ASCII protocol are the same as those described for the Modbus RTU protocol in **Instrument Exception Status** on page 60.

### Data

The format of the data variables from the instrument is as follows:

8 9 1 2 3 . 4 5 6								M W h							E N E R G Y													
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	22	23	24	25	26	27			
Value (aligned right)											space	Unit (aligned left)							space	Item (aligned left)								

**Note:** The decimal point in the Value is always at character position 8. Therefore whole numbers are aligned right at the decimal point, with trailing zeroes.

## Variables Request

The variables request asks the instrument to return the value of one or more requested variables. All totals are transmitted as accumulated totals.

Command	Description
:RVA?	Return all variables
:RVD?	Return the default Total and Rate
:RV0? ... :RV9?	Return the specific variable. The numbers relate to the position in the variables menu. For example, V0 is Energy, V1 is Power and so on.

## Variables Request and Response Example

The following request is for the only instrument that is connected to the communication port to return the values of all main menu variables.

```
: A 0 0 1 : R V A ? LF CR
```

The following is an example of a hypothetical instrument response. Refer to on page 25 for the list of variables that would be returned for this application.

```
A 0 0 1 2 0 0 2 / 0 3 / 1 4 1 8 : 2 5 : 0 0 0 0 LF CR
      6 . 1 1 6 M W h E N E R G Y LF CR
      1 6 . 5 7 3 M W P O W E R LF CR
      1 3 2 0 . 5 3 0 m 3 V O L U M E LF CR
      5 8 . 3 0 0 m 3 / M V - F L O W LF CR
      7 6 2 7 . 1 1 7 K G M A S S LF CR
      3 4 4 . 4 6 0 K G / M M - F L O W LF CR
      2 3 0 . 0 0 0 D E G C T E M P LF CR
      1 . 2 6 0 M P A P R E S S LF CR
      0 . 1 7 4 m 3 / K G S P - V O L LF CR
      2 8 8 6 . 7 6 0 K J / K G S P - E N T LF CR
LF CR
```

The following message to an instrument, requests the current values for the default rate and total:

```
: A 0 0 1 : R V D ? LF CR
```

The instrument response would be similar to the following:

```
A 0 0 1 2 0 0 2 / 0 3 / 1 4 1 8 : 2 5 : 0 0 0 0 LF CR
      1 2 6 . 4 5 5 m 3 V O L U M E LF CR
      2 0 . 4 3 7 m 3 / M V - F L O W LF CR
LF CR
```



## Log Request

The log request asks the instrument how many logs will be included in a printed log report. These are the values described in [Time Settings and Data Logging](#) on page 43.

Command	Description
:RLR?	Return the number of log records (non-timebased logging)

## Log Response Example

The following message asks the instrument with address 001 to return the number of log records that the instrument stores:

```
: A 0 0 1 : R L R ? LF CR
```

The instrument response would be similar to the following:

```
A 0 0 1 2 0 0 2 / 0 3 / 1 4 1 8 : 2 5 : 0 0 0 0 LF CR
2 4 LF CR
LF CR
```

## Clear Data Request

The clear data request asks the instrument to clear the data in the selected registers.

Command	Description
:RCN?	Clear the non-accumulated (resettable) totals
:RCA?	Clear the accumulated totals
:RCL?	Clear the logs except for the “last edited” log

## Clear Data Request Example

The following message asks the instrument with address 001 to clear the logged data that the instrument stores:

```
: A 0 0 1 : R C L ? LF CR
```

The instrument response would be similar to the following:

```
A 0 0 1 2 0 0 2 / 0 3 / 1 4 1 8 : 2 5 : 0 0 0 0 LF CR
LF CR
```

### Instrument Information Request

The Instrument Information request asks the instrument to return the general information about the model and version codes. The instrument exception status is returned as a part of the header as it is with the header for all command responses.

Command	Description
:RIG?	Return the general information about the instrument such as Model number, Application number, Version and Serial numbers etc. These items are returned as a block in the same format as shown on the display in the “Model Info” menu.

### Instrument Information Response Example

The following message asks the instrument with address 001 to return the general information about the instrument:

```
: A 0 0 1 : R I G ? LF CR
```

The following is an example of a hypothetical instrument response:

```
A 0 0 1   2 0 0 2 / 0 3 / 1 4   1 8 : 2 5 : 0 0   0 0 LF CR
5 1 5           M O D E L       - 1 - - F - LF CR
S C 0 1       I N P U T       F - T P - - LF CR
S C 0 1       V E R S       0 1 0 1 . 0 0 1 LF CR
C U S T O M   V E R S       0 0 0 0 0 1 LF CR
U N I T       S / N         1 2 3 4 5 6 LF CR
LF CR
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |10|11|12|13|14|15|16|17|18|19|20|21|22|23|24|25|26|27|28|29|
```

### Corrupted or Invalid Requests

If the instrument receives a corrupted or incomplete request, there is no response. The instrument discards any partial request and waits for the next enquiry.

If the instrument receives a request message in the correct format, but for a non-existent option, it returns only the message header. For example, if the instrument received the following request variables message :A001:RVT? it will return only the header because there is no T option for the ‘Variables Request’ message.

## 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 tables describe the addresses and meaning of the data registers in the instrument. The registers are grouped in blocks that relate to a particular function of the instrument. The data values are expressed in the engineering units that were selected for the variables when the instrument settings were configured.

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

The data registers represent different data types as specified in the tables:

- I - Integer, 2 bytes (Holding Register)
- L - Long Integer, 4 bytes (2 registers)
- P - Programmable Format, 4 bytes (2 registers)

The “Programmable Format” data type for 4-byte (2 registers) data values can be set as either Floating Point or Long Integer. 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.

### 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 type 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	Data Type
1	Net Volume	Process Variables	R	P
3	Net Flowrate		R	P
5	Main Line Volume		R	P
7	Main Line Flowrate		R	P
9	Process Line Volume		R	P
11	Process Line Flowrate		R	P
13	Volumetric Ratio		R	P
15	Flowrate Ratio		R	P
17	Flowrate Deviation		R	P
19			R	P
21			R	P
23			R	P
25			R	P
27			R	P
29		R	P	

Register	Name	Comments	Read Only or Read/Write	Data Type
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			I

### Instrument Exception Status

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

Register	Name	Comments	Read Only or Read/Write	Data 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 = error detected: no flow 13 = error detected: overflow 14 = error detected: leakage 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

## 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	Data Type
42	Reserved			I
43	Logic Inputs	0 to 15 Binary representation of logic inputs 0 = activated; 1 = deactivated  B0 = input 1 (LSB) B1 = input 2 B2 = input 3 B3 = input 4	R	I
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	Relay State	0 to 15 Binary representation of relay state 0 = open; 1 = closed  B0 = relay 1 (LSB) B1 = relay 2 B2 = relay 3 B3 = relay 4	R	I
46	Relay Control	0 to 15 Binary representation of relay control 0 = open; 1 = close  B0 = relay 1 (LSB) B1 = relay 2 B2 = relay 3 B3 = relay 4	R/W	I
47	Relay Control Source	0 to 15 Binary representation of relay control source 0 = Local - controlled by instrument operation 1 = RTU - controlled by Modbus register 46  B0 = relay 1 (LSB) B1 = relay 2 B2 = relay 3 B3 = relay 4	R/W	I
48	Delivery Number	Holds the delivery number (batch record) for a current or stored transaction (determined by Modbus register 38)	R	L
50	Control Mode	0 = Idle/Local      Control from logic inputs 1 = Stop              Stop delivery 2 = Run                Start delivery 3 = Reset              Clear totals	R/W	I
51 to 99	Instrument Parameters	See next table for details.	R/W	P

Register	Name	Comments	Read Only or Read/Write	Data Type
101	Analog Inp.1	Raw analog input data	R	P
103	Analog Inp.2	4-20mA inputs are read in Amperes	R	P
105	Analog Inp.3	0-5V or 1-5V inputs are read in Volts	R	P
107	Analog Inp.4	RTD inputs are read in degrees Kelvin	R	P
		Unused inputs are configured as 4-20mA		

### Instrument Configuration Parameters

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

The usage of these parameters can be dependent on other instrument settings. For full description, please refer to the 'Modbus Accessible Parameters' in [Parameters](#) on page 33.

Register	Name	Comments	Read Only or Read/Write	Data Type
51	Preset Ratio Setpoint		R/W	P
53	Preset Batch Value		R/W	P
55	Preset Flush Value		R/W	P
57 to 99	Reserved		R/W	P



## 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 is determined by the value 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
- PRN-04 Label (roll) printer - Citizen CMP30L

### 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 certain 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 21

**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 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 the printer as it is for 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.

*Delivery No. Date & Time & Status*

*Variable                    unit    value*

*Variable                    unit    value*

*etc.*

----- <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 the printer being off-line, the print head not engaged or the 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

## Glossary

---

<b>ASCII</b>	American Standard Code for Information Interchange. For the ASCII protocol, the instrument receives and transmits messages in ASCII, with all command strings to the instrument terminated by a carriage return. Replies from the instrument are terminated with a line-feed and a carriage-return.
<b>IrDA</b>	The Infra-red Developers Association is a group of computer and software manufactures who have agreed on a format for communication among infrared devices.
<b>K-factor</b>	The K-factor is a constant value associated with frequency type flowmeters. It is a scaling factor used in calculations to determine volumetric flow rate.
<b>Modbus RTU</b>	The Modbus protocol is a message structure for communications between controllers and devices regardless of the type of network. In RTU (remote terminal unit) mode, each 8-bit byte in a message contains two 4-bit hexadecimal characters. This mode has greater character density than ASCII and allows better data throughput than ASCII for the same baud rate.
<b>Normalised Input</b>	A normalised input ranges from 0 to 1.000. For 4-20mA input, the signal is set to 0 at 4mA and the signal is set to 1.000 at 20mA.
<b>NPS</b>	Namur Proximity Switch.
<b>Passive Output Signal</b>	Requires an external power supply.





# Appendix B

## Model Numbers

### Product Codes

Model	Supplementary Code		Description
515	- CB01		
Enclosure	1		Panel mount enclosure
	2		Field mount enclosure (NEMA 4X / IP66)
	3/5		Explosion proof Ex d (IECEX/ATEX), metric glands (5 specifies heater)
	4/6		Explosion proof Ex d (CSA), NPT glands (6 specifies heater)
Output Options	0	N/A	4 logic inputs, 1 isolated output, 2 relays (only relay type 1 is available), RS232 (DB9) communication port
	1		4 logic inputs, 2 isolated outputs, 4 relays, real-time clock data logging, RS232 (DB9) and RS485 communication ports
	2/3		4 logic inputs, 2 isolated outputs, 4 relays, real-time clock data logging, RS232 (DB9) and Ethernet/RF communication ports (not yet available)
Relay Type	1		Electromechanical relays only
	2		2 electromechanical and 2 solid state relays
	3		Solid state relays only (not yet available)
Power Supply	U		Inputs for 12-28VDC and 100-240 VAC, 50-60Hz <i>(Previous Models: A = 110/120 VAC, E = 220/240 VAC)</i>
	D		Input for 12-28VDC power only
Display Panel Options	S		Standard option (now with backlight & LCD backup) <i>(original Full option: F, with Infra-Red comms, no longer available)</i>
PCB Protection	C		<b>Conformal coating</b> - required for maximum environmental operating range. Recommended to avoid damage from moisture and corrosion.
	N		<b>None</b> - suitable for IEC standard 654-1 Climatic Conditions up to Class B2 (Heated and/or cooled enclosed locations)
Application Pack Number	CB01		Defines the application software to be loaded into the instrument
For example: Model No. 515.112USC Displayed on the 500 Series as: Note: The first character represents the CPU installed (factory use only). The remaining 6 characters only represent hardware that affects the operation.			<b>2 - 1 - - 5 -</b> 515      MODEL

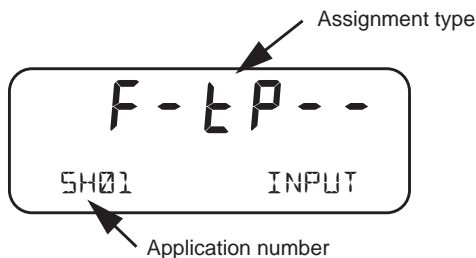
**Note:** Example full product part number is 515.112USC-CB01 (This is the number used for placing orders).

# Custom Version Codes

		Code	Description
<b>Origin Code</b> <b>Identifies Distributor</b>	00		Factory Default Application
	01		Contrec Systems Pty. Ltd. Melbourne Australia
	02		Contrec Limited. West Yorkshire UK
	03		
	04		Contrec - USA, LLC. Pelham AL 35124 USA
	05		Flowquip Ltd. Halifax UK
	06		
	etc.		
<b>User Language</b>	0		English (Default)
	1		German
	2		Dutch
	3		French
	4		Spanish
	5		
	etc.		
<b>Distributor's Code</b>	000		Distributor's own choice. Possibly a code that identifies the customer and the application.
	...		
	999		
For example: 02 3 157 Displayed on the 500 Series as:			<b>023 157</b> 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 Information code is returned as part of a General Instrument request (as described in **Instrument Information Request** on page 56).

---

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

- SC01 - steam flow computer for frequency flow meter
- GN02 - natural gas flow computer for analog flow meter

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

<b>FINP1</b>	<b>FINP2</b>	<b>AINP1</b>	<b>AINP2</b>	<b>AINP3</b>	<b>AINP4</b>
<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>

The codes are as follows:

- - - not used in this application
- *A* - indicates a generic analog input such as for density or level
- *d* - indicates a density input
- *F* - indicates a generic flow input such as for volume or mass, (frequency or analog)
- *H* - indicates a high flow input for stacked inputs
- *L* - indicates a low flow input for stacked inputs
- *P* - indicates a pressure input
- *Q* - indicates a quadrature input
- *t* - indicates a temperature input.

For example, *F - t P - -* is an instrument with FINP1 (frequency input 1) assigned to a flow input, AINP1 assigned to a temperature input and AINP2 assigned as a pressure input. The other inputs are not used.

# Appendix C

## 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 <sup>3</sup> , Km <sup>3</sup> , Ltr, mL, Gal, KGal, MGal, ft <sup>3</sup> , kft <sup>3</sup> , Mft <sup>3</sup> , bbl
Volume Flowrate	m <sup>3</sup> /s, m <sup>3</sup> /min, m <sup>3</sup> /h, m <sup>3</sup> /D, L/s, L/min, L/h, L/day, mL/s, mL/min, mL/hr, Gal/s, Gal/min, Gal/h, KGal/D, MGal/D, ft <sup>3</sup> /s, ft <sup>3</sup> /min, ft <sup>3</sup> /h, Mft <sup>3</sup> /D, bbl/s, bbl/min, bbl/h, bbl/D
Volume K-Factor	P/m <sup>3</sup> , P/Ltr, P/mL, P/Gal, P/ft <sup>3</sup> , 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 <sup>2</sup> , kg/cm <sup>2</sup> , kPa, MPa, mbar, bar, psi, Atm, inH <sub>2</sub> O, mmH <sub>2</sub> O
Density	kg/m <sup>3</sup> , kg/Ltr, lb/ft <sup>3</sup> , SG60F
Specific Volume	m <sup>3</sup> /kg, L/kg, ft <sup>3</sup> /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 <sup>2</sup> , ft <sup>2</sup>
Ratio	%
General Input	Pressure, Temperature, Density, Length (Level), Factor, Volume

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