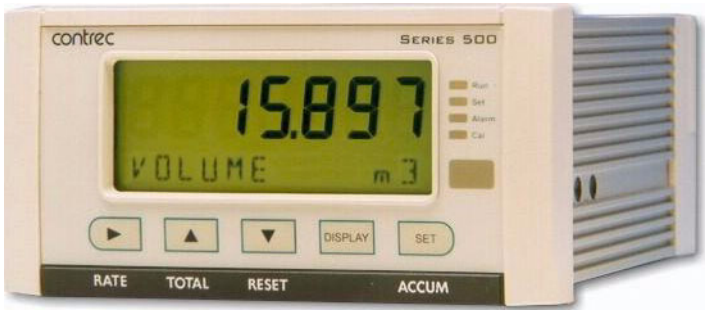
Model 515 Flow Computer

Operation Manual

Application GN01

Natural Gas (AGA-8 Detailed)
for
Frequency Flowmeters



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1 March 2004

Model 515 Flow Computer - Operation Manual

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

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

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Safety Notice

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

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

Qualified Personnel

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

Static Hazard

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

Voltage Hazard

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

Welding Hazard

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

Moisture Hazard

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

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- Selection of second language and user tags
- RTC logging with up to 100 entries at user-specified scheduled times
- Infra-red communications port on front panel
- Pulse width and scaling of pulse output
- 4-20mA retransmission
- Selectable communications protocol on serial ports including Modbus RTU
- Front panel adjustment of 8-24V DC output voltage
- Backlit display
- LCD backup

Overview

The 515 GN01 application measures the volume, mass and gross heat content of natural gas. The instrument uses a frequency volume flow input and analog temperature and pressure sensor inputs.

The instrument is compatible with a wide range of flowmeter frequency outputs. Millivolt signals, reed switches, Namur proximity switches or pulse trains can be selected via its smart front-panel programming.

The AGA-8 Detail Characterization Method is used to obtain accurate values of density and compressibility factors for the flow calculations.

Calculations

The following equations identify the derivation of some of the displayed variables. If your interest is more in the operation of the instrument, you can skip this section and allow the 500 to take care of the calculations.

The gas density and compressibility factor calculations are based on the AGA-8 equations. The calculations are valid for the region:

-130°C < t < 400°C P < 280 MPa
-200°F < t < 760°F P < 40000 psia

Formulas

$$Mflow = Volumeflow \bullet \rho_{flow}$$

$$Corrected\ flow = Mflow / \rho_{ref}$$

$$Heat\ flow = Mflow \bullet H_m$$

where:

$Mflow$	=	mass flow
ρ_{flow}	=	density at flow conditions
ρ_{ref}	=	density at reference conditions
H_m	=	mass gross heating value

For further details of these equations or restrictions of use please refer to the appropriate standard.

Analog Input Scaling

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

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

where:

P_{min}	=	*minimum point (equivalent to offset)*
P_{max}	=	*maximum point ($P_{max} - P_{min}$ is equivalent to span)*
A^*	=	*normalised signal (0 to 1) with correction applied for a flow input*

Displayed Outputs

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 data logging of up to 100 entries of the first ten variables as displayed on the main menu.

This application indicates the type of pressure value being displayed as either gauge or absolute by adding an ‘A’ or ‘G’ to the units of measure. Standard or Normal reference conditions are indicated by adding an ‘S’ or ‘N’ at the start of the Corrected Volume units or measure.

Main Menu Variables

Main Menu Variables	Default Units	Other available units of measure	Variable Type
Volume	m^3	m^3, Ltr, Gal, ft^3, kft^3, Mft^3	Total
Volume Flowrate	m^3/min	m^3/s, m^3/min, m^3/h, m^3/D, L/s, L/min, L/h, Gal/s, Gal/min, Gal/h, ft^3/s, ft^3/min, ft^3/h, Mft^3/D	Rate
Corrected Volume	m^3	m^3, Ltr, Gal, ft^3, kft^3, Mft^3	Total
Corrected Flowrate	m^3/min	m^3/s, m^3/min, m^3/h, m^3/D, L/s, L/min, L/h, Gal/s, Gal/min, Gal/h, ft^3/s, ft^3/min, ft^3/h, Mft^3/D	Rate
Heat	GJ	kJ, MJ, GJ, kWh, MWh, kBTU, Ton.h, therm, cal, kcal, Mcal	Total
Heat Flowrate	GJ/h	kJ/h, MJ/h, GJ/h, kW, MW, kBTU/min, kBTU/h, Ton, therm/min, therm/h, kcal/h, Mcal/h	Rate
Mass	kg	kg, g, Ton, lb	Total
Mass Flowrate	kg/min	kg/s, kg/min, kg/h, g/s, g/min, g/h, Ton/min, Ton/h, Ton/D, lb/s, lb/min, lb/h	Rate
Temperature	Deg C	Deg K, Deg C, Deg F, Deg R	Rate
Pressure	MPa	Pa, kg/m^2, kg/cm^2, kPa, MPa, mbar, bar, psi, Atm, inH_2O, mmH_2O	Rate
Compressibility Factor	- - -	Unitless factor	Rate

Communications

There are three communication ports available as follows:

- RS-232 port (standard)
- RS-485 port (advanced option)
- Infra-red port (on front panel)

These ports are available for remote data reading and for initial application loading of the instrument.

Isolated Outputs

The two opto-isolated outputs in the advanced option can retransmit any main menu variable. The type of output is determined by the nature of the assigned variable. Totals are output as pulses and rates are output as 4-20mA signals.

Relay Outputs

The relay alarms can be assigned to any of the main menu variables of a rate type. The alarms can be fully configured including hysteresis. Two relays are standard with four available in the advanced option.

Software Configuration

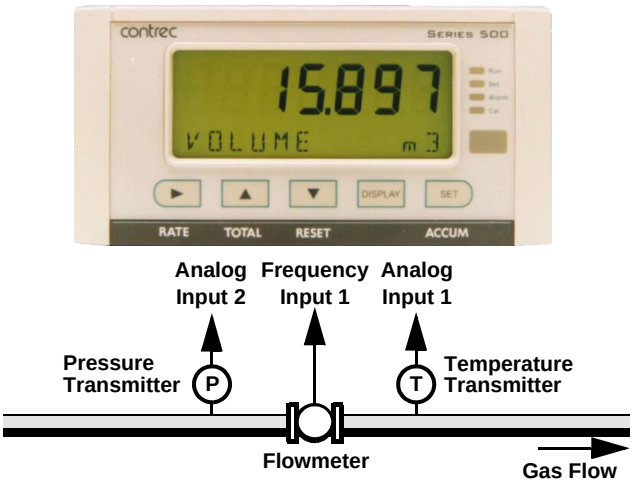
The instrument can be further tailored to suit specific application needs including units of measure, custom tags, second language or access levels. A distributor can configure these requirements before delivery.

Most other parameters can be programmed in the field, according to the user-access levels assigned to the parameters by the distributor.

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

Temperature and Pressure Input Types

Temperature sensor input can be either PT100, 4-20 mA, 0-5 V or 1-5V signals. Pressure sensor input can be either 4-20 mA, 0-5 V or 1-5V signals.



Limitations of Use

AGA-8 Limits

To achieve the intended accuracy and targeted uncertainty of the AGA-8 standard for the computations of physical properties of gases, the component mole percentages must not be outside the ranges given in the table below.

The normal range column gives the range of gas characteristics for which the average expected uncertainty is as low as 0.1% for the region -8°C to 62°C and 0 to 12 MPa (17°F to 143°F and 0 to 1250 psia). The expanded range allows for greater flexibility with more pure gases and a wider percentage for gas components but does have an average uncertainty which is expected to be higher, especially outside the above region. (Refer to the AGA-8 standard for more details.)

Component	Normal Range	Expanded Range
Mole percent of Methane	45.0 to 100.0	0 to 100.0
Mole percent of Nitrogen	0 to 50.0	0 to 100.0
Mole percent of Carbon Dioxide	0 to 30.0	0 to 100.0
Mole percent of Ethane	0 to 10.0	0 to 100.0
Mole percent of Propane	0 to 4.0	0 to 12.0
Mole percent of Total Butanes	0 to 1.0	0 to 6.0
Mole percent of Total Pentanes	0 to 3.0	0 to 4.0
Mole percent of Hexanes Plus	0 to 0.2	0 to dew point
Mole percent of Helium	0 to 0.2	0 to 3.0
Mole percent of Hydrogen	0 to 10.0	0 to 100.0
Mole percent of Carbon Monoxide	0 to 3.0	0 to 3.0
Mole percent of Argon	#	0 to 1.0
Mole percent of Oxygen	#	0 to 21.0
Mole percent of Water	0 to 0.05	0 to dew point
Mole percent of Hydrogen Sulphide	0 to 0.02	0 to 100.0

The normal range is considered to be zero for these compounds.

Heating Values

The instrument calculates the heating value of natural gas in accordance with ISO 6976:1995 and GPA Standard 2172-96 for dry gas. The wet gas calculations include the latent heat of vaporisation of the water component. This complies with the ISO recommendations and the appendixes to AGA 3 and AGA 8.

Note: The GPA standard does not recommend including the latent heat of vaporisation of the water component. However, even for a gas saturated with water vapour at 20°C, the value of this latent heat contributes only about 0.1% to the gross heating value and considerably less at lower combustion temperatures. Such a heating value is within the uncertainties of the properties reported in the GPA standard.

Approvals

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

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

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

Chapter 2
Specifications

General

Operating Environment

Temperature	-20°C to +60°C (conformal coating) +5°C to +40°C (no coating)
Humidity	0 to 95% non condensing (conformal coating) 5% to 85% non condensing (no coating)
Power Supply	95...135 V AC or 190...260 V AC or 12...28 V DC
Consumption	Typically 6W
Protection	Sealed to IP65 (Nema 4X) when panel mounted
Dimensions	147mm (5.8") width 74mm (2.9") height 167mm (6.6") depth

Display

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

Non-volatile Memory

Retention	> 30 years
Data Stored	Setup, Totals and Logs

Approvals

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

Real Time Clock (Optional)

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

Gas Properties Calculations (AGA- 8)

Update Rate	1 sec - gas composition unchanged 2 sec - when changed, 10 components 4 sec - when changed, 21 components

Inputs

Frequency Input (General)

Range	0 to 10kHz
Overvoltage	30V maximum
Update Time	0.3 sec
Cutoff frequency	Programmable (default at 0.25Hz)
Configuration	Pulse, coil or NPS input
Non-linearity	Up to 10 correction points

Pulse

Signal Type	CMOS, TTL, open collector, reed switch
Threshold	1.3 volts

Coil

Signal Type	Turbine and sine wave
Sensitivity	15mV p-p minimum

NPS

Signal Type	NPS sensor to Namur standard

Analog Input (General)

Overcurrent	100mA absolute maximum rating
Update Time	< 1.0 sec
Configuration	RTD, 4-20mA, 0-5V and 1-5V input
Non-linearity	Up to 20 correction points (flow inputs)

RTD Input

Sensor Type	PT100 to IEC 751
Connection	Four Wire
Range	-100°C to 300°C
Accuracy	0.1°C typical

4-20mA Input	
Impedance	100ohms (to common signal ground)
Accuracy	0.05% full scale (20°C) 0.1% (full temperature range, typical)

0-5 or 1-5 Volts Input	
Impedance	10Mohms (to common signal ground)
Accuracy	0.05% full scale (20°C) 0.1% (full temperature range, typical)

Logic Inputs	
Signal Type	CMOS, TTL, open collector, reed switch
Overvoltage	30V maximum

Outputs

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

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

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

Isolated Output (Optional)	
No. of Outputs	2 configurable outputs
Configuration	Pulse or 4-20mA output

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

4-20mA Output	
Supply	9 to 30 volts DC external
Resolution	0.05% full scale
Accuracy	0.05% full scale (20°C) 0.1% (full temperature range, typical)

Important: Specifications are subject to change without notice.

Chapter 3
Installation

Panel Mounting

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

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

Figure 1 shows the panel mounting requirements for the 500 Series Instrument.

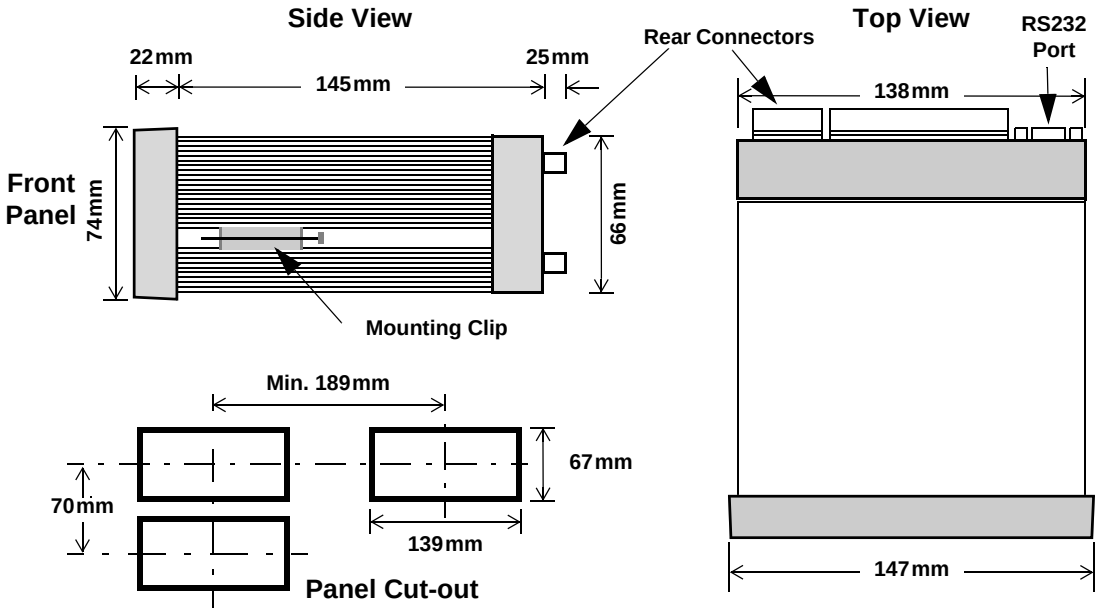


Figure 1 500 Series Instrument Panel Mounting

Electrical Connection

Rear Panel Connections

Figure 2 shows the connections on the rear panel of the instrument.

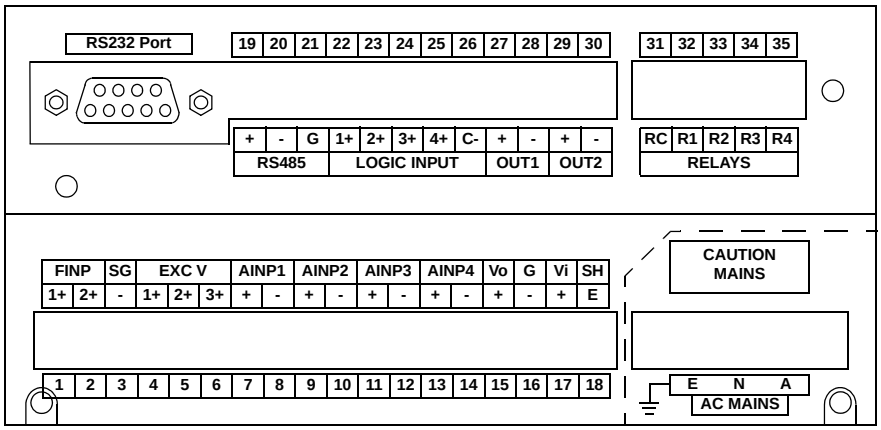


Figure 2 Rear Panel Connections

Terminal Designations

Terminal Label			Designation	Comment
1	FINP	1+	Frequency Input 1+	Volumetric flow input
2	FINP	2+	Frequency Input 2+	Not used
3	SG	-	Signal ground	
4	EXC V	1+	Excitation Term 1+	Not used
5	EXC V	2+	Excitation Term 2+	For AINP1
6	EXC V	3+	Excitation Term 3+	Not used
7	AINP1	+	Analog input ch 1 (+)	Temperature input
8		-	Analog input ch 1 (-)	
9	AINP2	+	Analog input ch 2 (+)	Pressure input
10		-	Analog input ch 2 (-)	
11	AINP3	+	Analog input ch 3 (+)	Not used
12		-	Analog input ch 3 (-)	
13	AINP4	+	Analog input ch 4 (+)	Not used
14		-	Analog input ch 4 (-)	
15	Vo	+	8-24 volts DC output	Overload protected
16	G	-	DC Ground	
17	Vi	+	DC power input	DC power in 12-28V
18	SH	E	Shield terminal	
E	AC MAINS	E	Mains ground	AC power in 95-135V or 190-260V
N		N	Mains neutral	
A		A	Mains active	

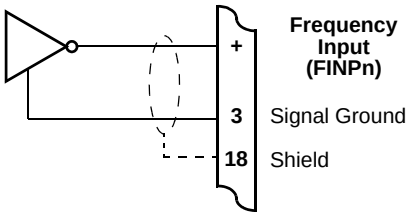
Terminal Label			Designation	Comment
19	RS485	+	RS485 (+)	Advanced option
20		-	RS485 (-)	
21		G	RS485 ground	
22	LOGIC INPUTS	1+	Switch 1	Advanced option
23		2+	Switch 2	
24		3+	Switch 3	
25		4+	Switch 4	
26		C-	Signal ground	
27	OUT 1	+	Output ch 1 (+)	Advanced option
28		-	Output ch 1 (-)	
29	OUT 2	+	Output ch 2 (+)	Advanced option
30		-	Output ch 2 (-)	
31	RELAYS	RC	Relay common	Standard version
32		R1	Relay 1	
33		R2	Relay 2	
34		R3	Relay 3	Advanced option
35		R4	Relay 4	
RS232 port			9-pin serial port	Standard version

Inputs

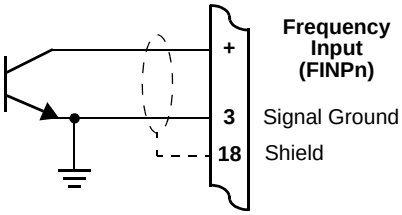
Frequency Input Connection

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.

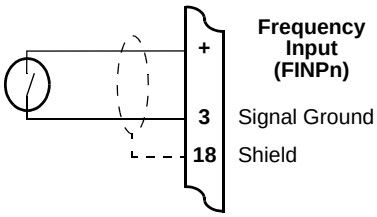
Squarewave, CMOS or TTL



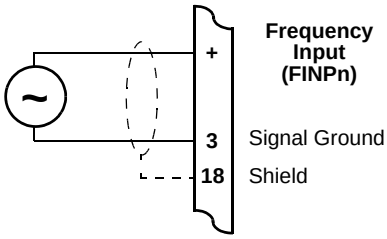
Open Collector



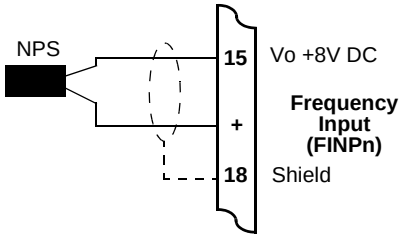
Reed Relay Switch



Coils - with 15 millivolts peak to peak AC minimum



Namur Proximity Switch



Analog Input Connections

All analog inputs can accept DC signals ranging from 0-5V, 1-5V and current signals from 4 to 20 mA.

Analog Input 1 (AINP1) can also accept an RTD input (PT100) as well as the standard 0-5 V, 1-5V and 4 to 20 mA input.

CAUTION

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

0-5 and 1-5 Volt Inputs

For externally powered voltage transmitters, connect each transmitter to a pair of input terminals as shown in Figure 3. Refer to **Terminal Designations** on page 10 for specific terminal numbers for this application.

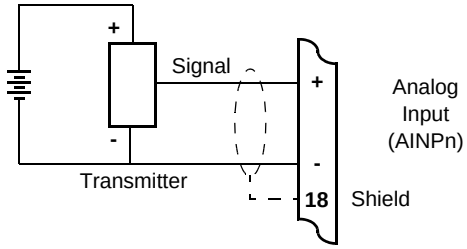


Figure 3 Externally Powered Voltage Transmitter

Connect internally powered voltage transmitters as shown in Figure 4.

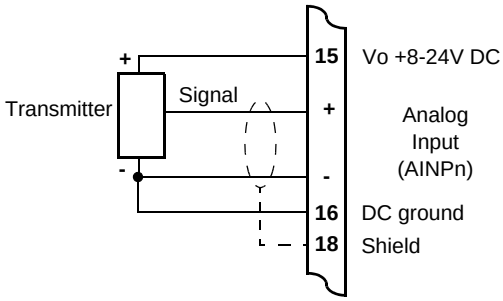


Figure 4 Internally Powered Voltage Transmitter

4-20mA Inputs

For an externally powered current loop, connect the transmitter to the input terminals as shown in Figure 5. Refer to **Terminal Designations** on page 10 for specific terminal numbers for this application.

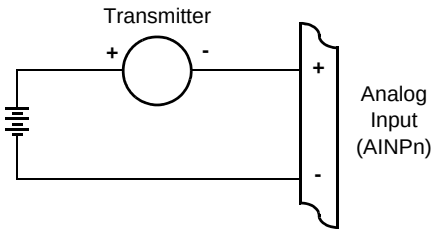


Figure 5 Externally Powered Current Loop

The internal overload-protected power supply has sufficient power for three current loops at 24V DC (more current loops can be supplied by using a reduced voltage setting). Connect internally powered current loops as shown in Figure 6.

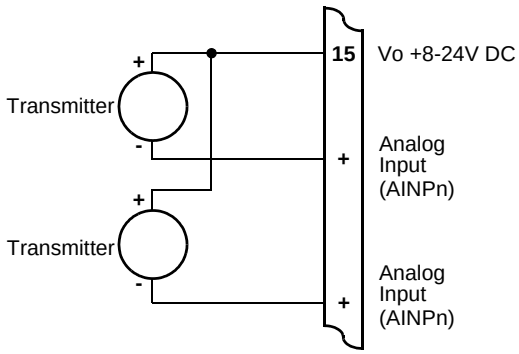


Figure 6 Internally Powered Current Loops

RTD Input

The instrument uses 4-wire RTDs to provide optimum accuracy and stability. It is not necessary to have equal cable lengths for the 4-wire RTDs, but they should be no longer than 50 metres. It is also recommended to use shielded twisted pairs.

Connect RTD inputs as shown in Figure 7.

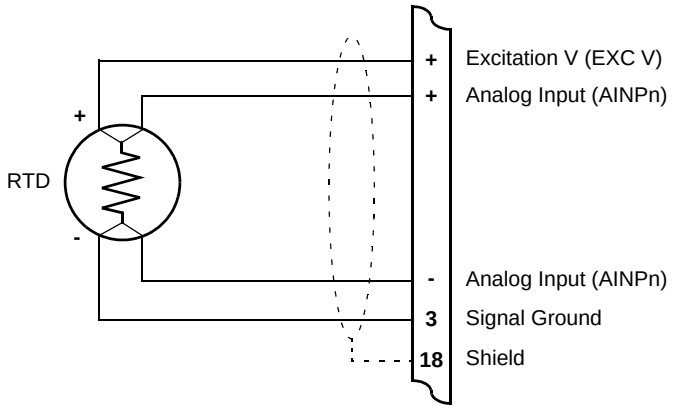


Figure 7 RTD Connection

Only Analog Input 1 (AINP1) is available for RTD connection.

Excitation terminal 2 (pin 5) must be used in conjunction with AINP1.

It is possible to use two-wire or three-wire RTDs. However, four wires must be taken to the RTD, with the signal and current wires joined as close to the RTD as possible.

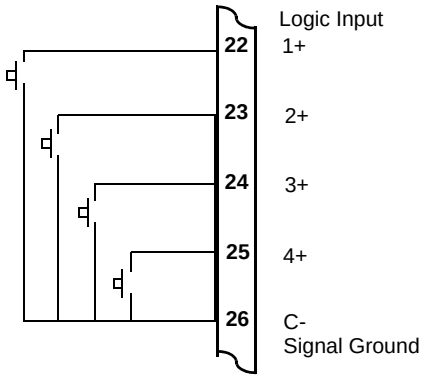
Note: The RTD has no polarity and can be connected in either direction. However, the excitation and the positive analog input must be connected to one side of the RTD. Similarly, the Signal Ground and the negative analog input must be connected to the other side of the RTD.

Logic Input Connection

These inputs are designed to be connected to CMOS, TTL, open collector signals or a voltage free contact switch.

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.



Outputs

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

4-20 mA Output Connection

Figure 8 shows the connections for a 4-20 mA 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

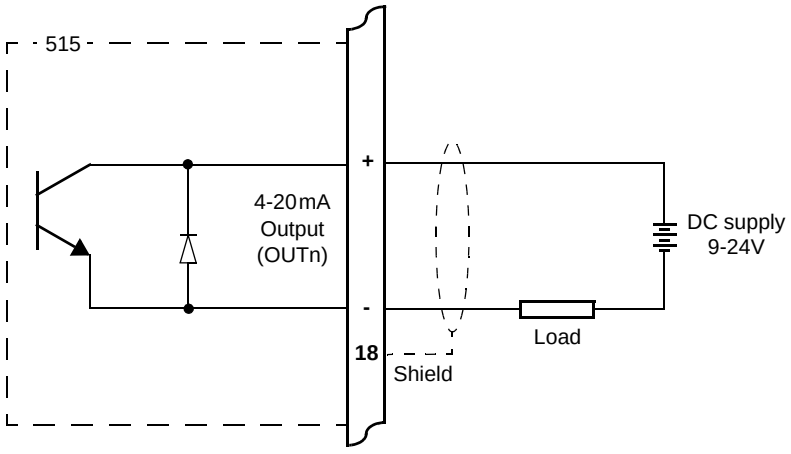


Figure 8 Output 4-20 mA Connection Diagram

Pulse Output Connection

Figure 9 shows a connection example for a pulse output. Output channel 1 uses terminals 27 (+) and 28 (-). Output channel 2 uses terminals 29 (+) and 30 (-).

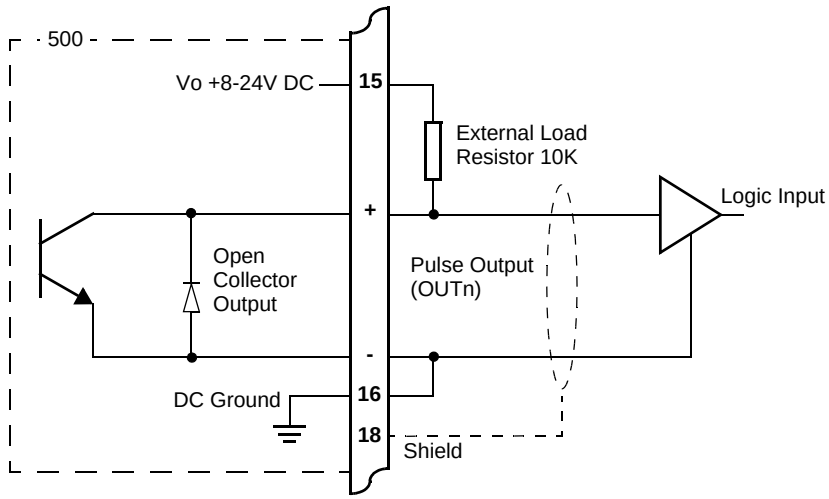


Figure 9 Output Pulse Connection Diagram

Alarms

The standard instrument has two alarm relays, which can be used to drive external devices such as external relays, lamps, and audible alarms. The advanced option has four alarm relays. The operation of each alarm relay can be set in calibration as high or low and as normally open or normally closed.

There is also an equipment failure alarm option. This alarm has normally closed contacts which open when the instrument displays any error message as listed in **Error Messages** on page 49, or if there is a loss of power to the instrument.

The output characteristics of the alarm relays are:

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

Figure 10 shows the connection of the alarm relays.

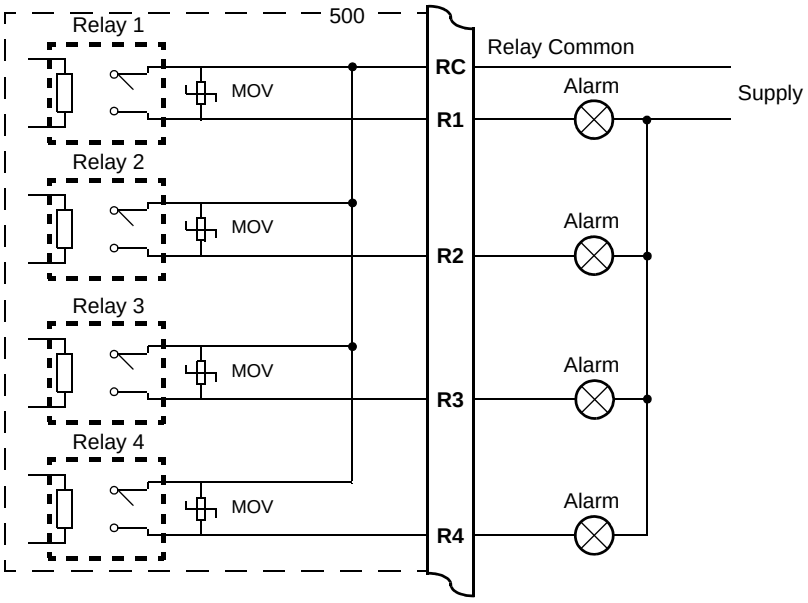


Figure 10 External Alarm Connection Diagram

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 0.25µF and 100Ω will usually suffice. Note that only mains-approved RC suppression networks should be used.

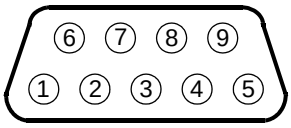
The basic principle of the operation is that the capacitor prevents a series of sparks arcing across the contact as the contact breaks. The series resistor limits the current through the contact when the contact first makes.

Communications

The communication protocols are described in **Communications** on page 51.

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 51 for cable termination requirements.

Infra-red Port (Display Panel Option)

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

RS-485 Port (Advanced Option)

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

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

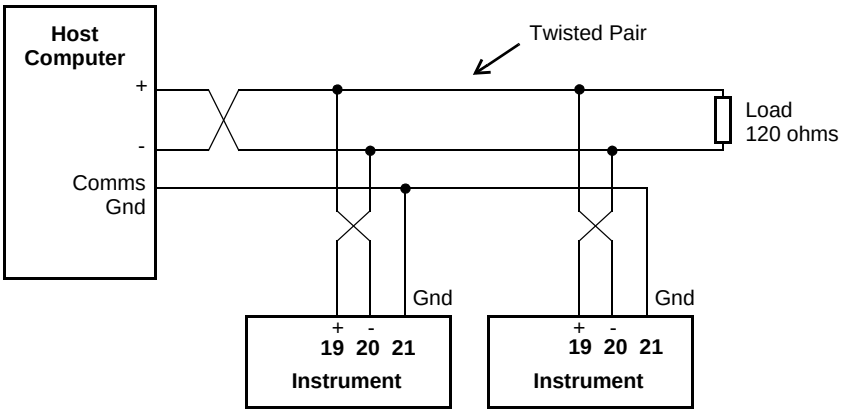


Figure 11 RS-485 Interface Connections

Earthing and Shielding

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

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

Chapter 4
Operation

Normal Operation

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

- Totals
- Rates
- Process variables
- Instrument settings

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

Total	**Rate**
Volume	Volume Flowrate
Corrected Volume	Corrected Flowrate
Heat	Heat Flowrate
Mass	Mass Flowrate

Default Total

In some applications, one set of variables is of more interest than others, and for this reason a default total and its associated rate can be assigned during instrument calibration. This default total can be used in two ways:

- The default variables come first in the sequence of totals and rates that are displayed with the front panel keys.
- If the display timeout option is enabled and no buttons are pressed for the selected period (usually 30 seconds) the display returns to the default total.

Status Lamps

The status lamps illuminate to show the following conditions:

Run The host computer is downloading the application software.
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 all resettable totals. The Total Reset function has three reset modes that are selectable during instrument calibration as follows:

- NONE - The user cannot reset the non-accumulated totals.
- INSTANT - When the user presses the **RESET** key, the instrument resets all non-accumulated totals.
- DELAYED - When the user holds the **RESET** key for two seconds, the instrument resets all non-accumulated totals.

The instrument makes three beeps when it resets the totals.

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.

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.

DISPLAY ↓	**Description**	**Options**
VOLUME	Gas volume	Hold the **ACCUM** key to display accumulated total
V-FLOW	Gas volume flowrate	
C-VOL	Gas corrected volume	Hold the **ACCUM** key to display accumulated total
C-FLOW	Gas corrected flowrate	
HEAT	Gas heat content (energy)	Hold the **ACCUM** key to display accumulated total

DISPLAY ↓	Description	Options
H-FLOW	Gas heat flowrate (power)	
MASS	Gas mass	Hold the ACCUM key to display accumulated total
M-FLOW	Gas mass flowrate	
TEMP	Gas temperature	
PRESS	Gas pressure	Hold the SET key to view the absolute value if the type of pressure sensor is set to GAUGE.
Z-FACT	Compressibility Factor	
LOGGED DATA		Hold the SET key to display data logs as described in **Data Logs** on page 23.
MODEL INFO		Hold the SET key to display the Model information as described in **Model Information** on page 25.
CAL MENU		Hold the SET key to enter Calibration View mode as described in **Calibration View Mode** on page 27.

Data Logs

The instrument can log the first ten main-menu variables. The logs are at fixed intervals which can be programmed to a combination of hours, days, weeks, months and years. The instrument can store a total of 100 log entries. Note that the totals are saved as accumulated totals.

If the number of log entries exceeds the programmed number for a particular time interval, the oldest log entry is overwritten by the newest one for that time interval.

The log entries are recorded at the following times:

HOUR	00 minutes each hour
DAY	00 hours and 00 minutes each day
WEEK	00 hours and 00 minutes each Monday
MONTH	00 hours and 00 minutes on the first day of the month
YEAR	00 hours and 00 minutes on the first day of the year.

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 hourly log. The HOUR legend flashes alternately with the number of the logged item, for example LOG-01.

The following example shows the hourly log at 15:00 (3:00 pm) on 16 January 2002.

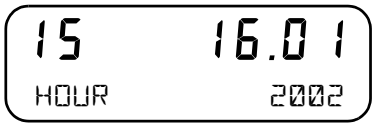


Figure 12 shows how to display the logged data.

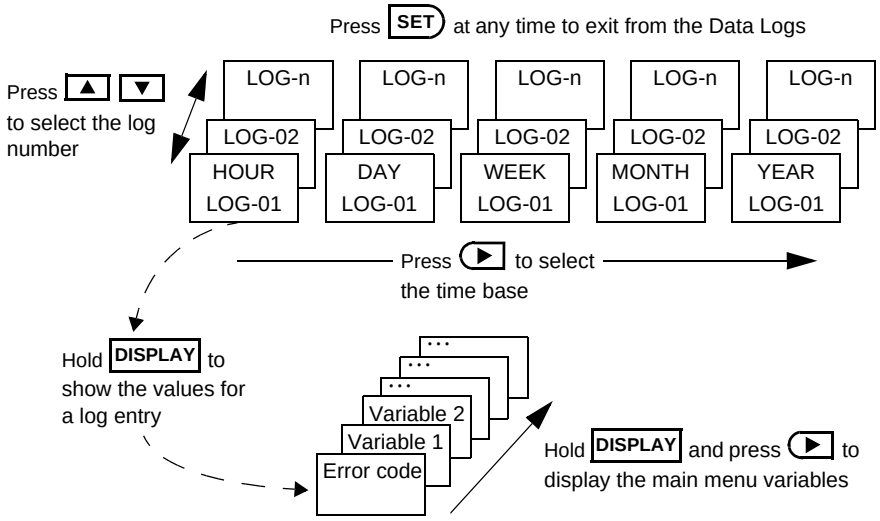


Figure 12 Logged Data Display Methods

Model Information

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

DISPLAY ↓	Description
- 10 - F - 515 MODEL	The hardware model code. Refer to **Product Codes** on page 67 for more information.
F - tP - - GN01 INPUT	The Application number and the assignment of the inputs. Refer to **Application Information Code** on page 68 for more information.
0 10 1.002 GN01 VERS	The version of software loaded into the instrument.
026357 CUSTOM VERS	The Customer version code for this installation. Refer to **Custom Version Codes** on page 68 for more information.
123456 SERIAL No	The serial number of the instrument.
16 27.08 EDITED 2002	The time and date when the calibration of the instrument was last edited. The format of the time and date is the same as for the data logs. This example shows 16:00 (4:00pm) on the 27th August 2002. This function is available only if the instrument has the real time clock option.

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

Chapter 5
Instrument Calibration

Introduction

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

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

Note: When you enter Calibration Set mode, the instrument requests you to enter a password. You can enter any "incorrect" password to change the settings of the "programmable" parameters. You must enter the correct password to change the password-protected parameters.

Calibration View Mode

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

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

2. Hold the SET key.

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

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

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

The instrument returns to Normal Operation mode.

Calibration Set Mode

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

Use the following procedure to enter Calibration Set mode:

1. Press DISPLAY to scroll to the CAL MENU prompt.
2. Hold the SET key.

Run
Set
Alarm
Cal

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

3. Press ▶ to select any flashing menu heading except END.
4. Hold SET for two seconds.

The instrument requests a password.

5. Press ▲ or ▼ to change the value of the current digit. To select the next digit, press ▶.
6. Press SET to accept the password.
   - The instrument makes two beeps for a correct password entry and enables you to change the “programmable” and “password-protected” parameters.
   - The instrument makes one beep for an incorrect password entry and enables you to change only the “programmable” parameters.

Run
Set
Alarm
Cal

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

7. Edit the instrument parameters as required. The programmable values are indicated by the flashing display.
   - To change a numerical value, press ▲ to increase a value, or press ▼ to decrease a value. Press a key momentarily to change the value one number at a time. Hold a key to scroll through the numbers. To proceed to next digit, press ▶.
   - To change an option setting, press ▲ or ▼ to scroll through the options.
8. Press SET to accept the currently displayed value and proceed to the next parameter. You can press DISPLAY to return to the main calibration menu.
9. To exit from Calibrate Set mode, press ▶ to scroll through the main calibration menu to END, then press SET. Otherwise, from any menu, you can press and hold SET for two seconds.

Run
Set
Alarm
Cal

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

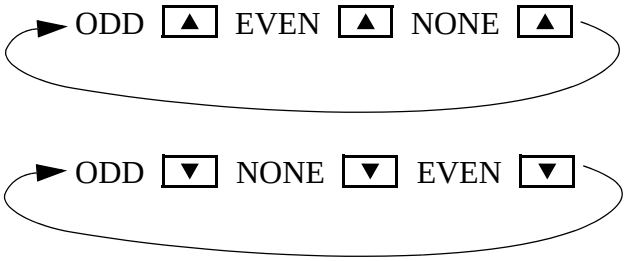
Changing the Instrument Settings

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

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

Changing Option Settings

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



Changing Numeric Settings

The display flashes the digit that can be changed.

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

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

Changing the Decimal Point

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

Engineering Units

The calibration of some parameters is based on the engineering units that are defined for the relevant variables as described in **Main Menu Variables** on page 3.

Calibration Menu Tree

Figure 13 and Figure 14 show the keys for moving around the calibration menu tree in Calibration View or Set mode.

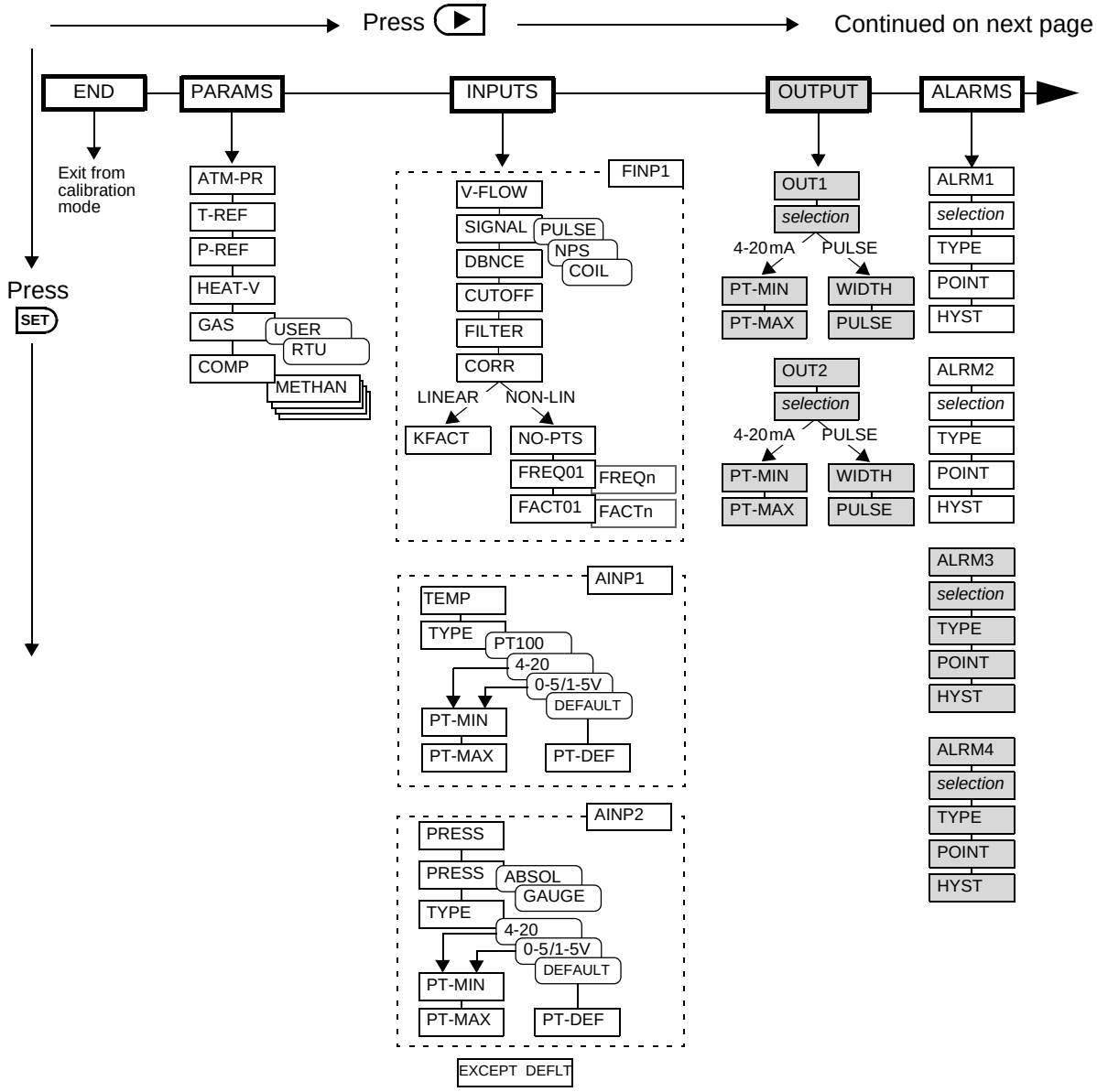


Figure 13 Calibration Menu Tree Sheet 1

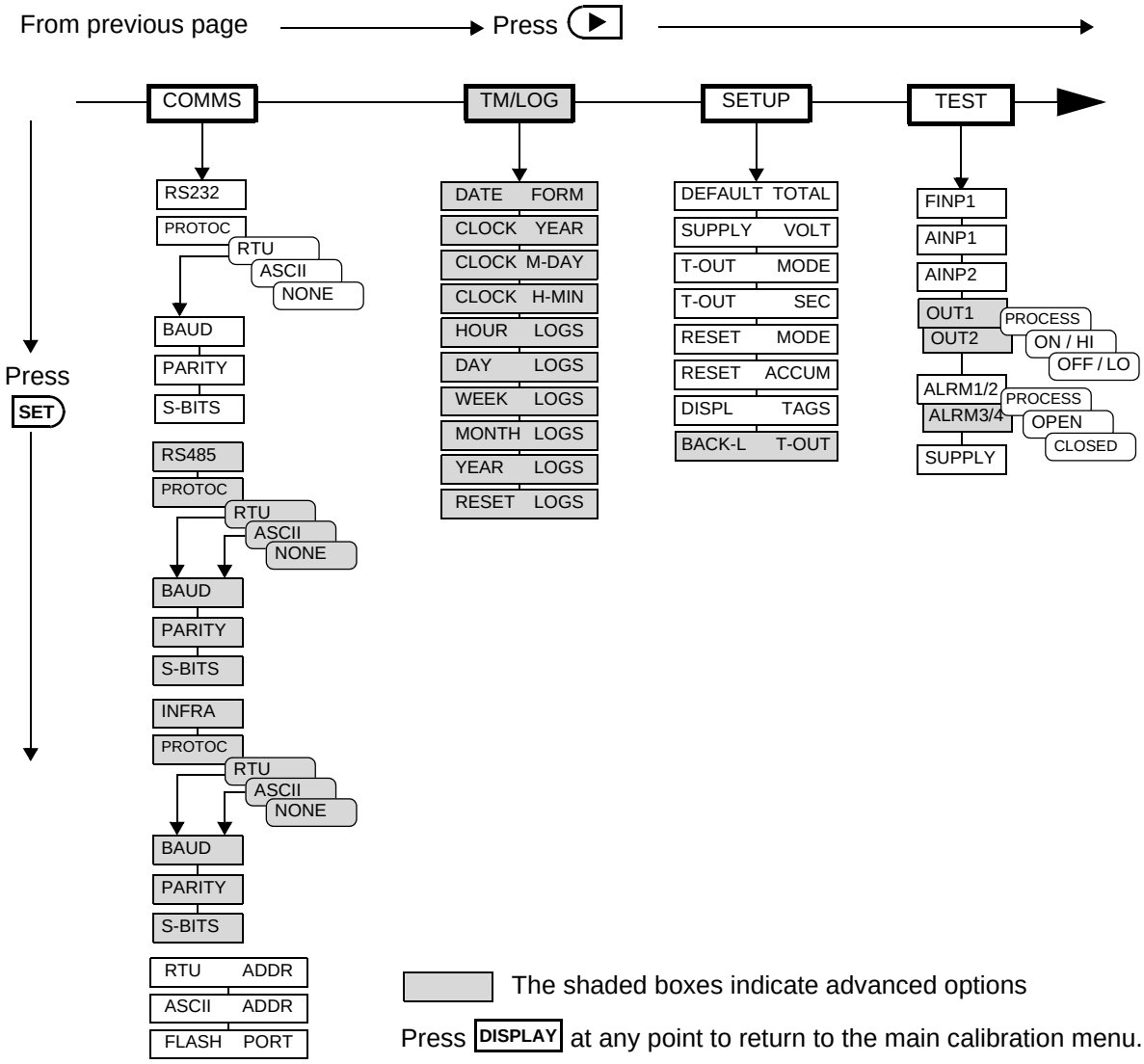


Figure 14 Calibration Menu Tree Sheet 2

Instrument Settings

Parameters

SET ↓	▶ → END **PARAMS** INPUTS OUTPUTS ALARMS COMMS TM/LOG SETUP TEST
ATM-PR *unit*	If the pressure sensor is configured as a Gauge type sensor, the instrument adds the atmospheric pressure to the measured pressure to determine the absolute pressure. Set the atmospheric pressure (absolute) according to the height above sea level.
T-REF *unit*	Enter the reference temperature for the calculation of corrected natural gas volume flow.
P-REF *unit*	Enter the reference pressure (absolute) for the calculation of the corrected natural gas volume flow.
HEAT-V REF-T	Select the combustion reference temperature for the calculation of the natural gas heating value. Press ▲ or ▼ to select 0°C, 15°C, 20°C, 25°C, 60°F or 77°F.
GAS COMP	The instrument allows the molar composition values to be changed via either of two methods: • **User** - The instrument allows the composition values to be changed only by the user via the front panel. • **RTU** - The instrument allows the composition values to be changed via by Modbus RTU communications or by the user via the front panel. Press ▲ or ▼ to select User or RTU. **Note:** The instrument uses the compressibility factors for natural gas according to AGA-8. Refer to the *American Gas Association (AGA) Report No. 8* for the applicability to ranges of gas composition, temperature and pressure. Enter the following values as 00.000% to 99.999%.
METHAN MOLE%	Enter the mole percent of Methane in the natural gas.
NITROG MOLE%	Enter the mole percent of Nitrogen in the natural gas.
C-DIOX MOLE%	Enter the mole percent of Carbon Dioxide in the natural gas.
ETHANE MOLE%	Enter the mole percent of Ethane in the natural gas.
PROPAN MOLE%	Enter the mole percent of Propane in the natural gas.
WATER MOLE%	Enter the mole percent of Water in the natural gas.

SET ↓	▶ → END **PARAMS** INPUTS OUTPUTS ALARMS COMMS TM/LOG SETUP TEST
H-SULP MOLE%	Enter the mole percent of Hydrogen Sulphide in the natural gas.
HYDROG MOLE%	Enter the mole percent of Hydrogen in the natural gas.
C-MONO MOLE%	Enter the mole percent of Carbon Monoxide in the natural gas.
OXYGEN MOLE%	Enter the mole percent of Oxygen in the natural gas.
I-BUTN MOLE%	Enter the mole percent of i-Butane in the natural gas.
N-BUTN MOLE%	Enter the mole percent of n-Butane in the natural gas.
I-PENT MOLE%	Enter the mole percent of i-Pentane in the natural gas.
PENTAN MOLE%	Enter the mole percent of n-Pentane in the natural gas.
HEXANE MOLE%	Enter the mole percent of n-Hexane in the natural gas.
HEPTAN MOLE%	Enter the mole percent of n-Heptane in the natural gas.
OCTANE MOLE%	Enter the mole percent of n-Octane in the natural gas.
NONANE MOLE%	Enter the mole percent of n-Nonane in the natural gas.
DECANE MOLE%	Enter the mole percent of n-Decane in the natural gas.
HELIUM MOLE%	Enter the mole percent of Helium in the natural gas.
ARGON MOLE%	Enter the mole percent of Argon in the natural gas.

Inputs

SET ↓	▶ → END PARAMS **INPUTS** OUTPUTS ALARMS COMMS TM/LOG SETUP TEST
Frequency Input 1	
INPUT V-FLOW FINP1	For this application, Frequency Input Channel 1 is assigned to flowrate.
SIGNAL FINP1	Frequency input 1 signal type. Press ▲ or ▼ to select Coil, NPS or Pulse.

SET ↓	▶ → END PARAMS **INPUTS** OUTPUTS ALARMS COMMS TM/LOG SETUP TEST
DBNCE FINP1	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. **Note:** When the debounce circuit is enabled, the maximum input frequency for large amplitude signals is limited to approximately 500 Hz. For low amplitude signals, the maximum frequency can be approximately 200 Hz. Press ▲ or ▼ to select Enable or Disable.
CUTOFF FINP1	The Cut-off is the lowest frequency for which the instrument continues to calculate a rate from the flowmeter. The value for the cut-off is specified as the frequency of the flowmeter in Hertz. The default cut-off point is 0.25 Hz. Be careful when setting cut-off values below 0.25 Hz, because the display update time for the flow rate becomes very long. For example if the cut-off is set to 0.01 Hz, 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.

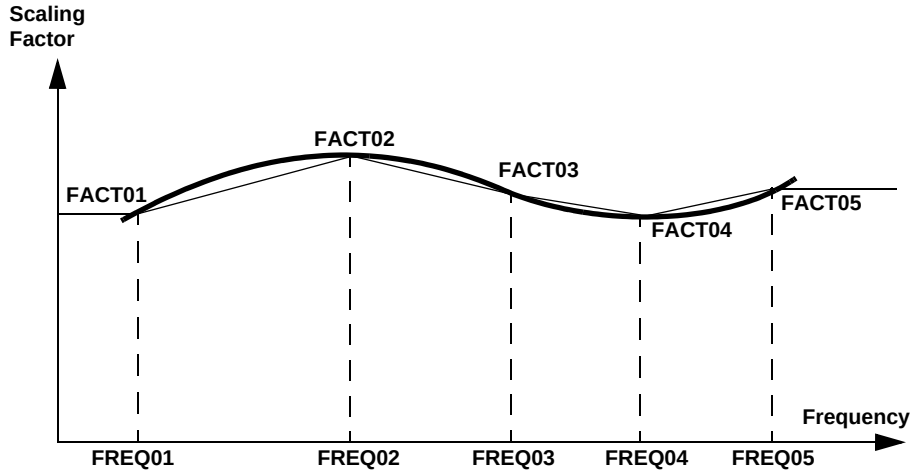
<table>
<tr><td>SET ↓</td><td>▶ → END PARAMS INPUTS OUTPUTS ALARMS COMMS TM/LOG SETUP TEST</td></tr>
<tr><td>FILTER FINP1</td><td>Input fluctuations caused by pulsating flow tend to create distortion in the input readings of the rate. The instrument has a digital filter that averages out these fluctuations.

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

The value A is the filter constant that the user can set.
<table>
<tr><th>Filter setting A</th><th>Seconds to reach 90% of full swing</th><th>Seconds to reach 99% of full swing</th></tr>
<tr><td>0</td><td>0</td><td>0</td></tr>
<tr><td>2</td><td>2</td><td>4</td></tr>
<tr><td>4</td><td>4</td><td>8</td></tr>
<tr><td>6</td><td>5</td><td>10</td></tr>
<tr><td>10</td><td>8</td><td>15</td></tr>
<tr><td>15</td><td>12</td><td>23</td></tr>
<tr><td>20</td><td>14</td><td>27</td></tr>
<tr><td>25</td><td>18</td><td>34</td></tr>
<tr><td>35</td><td>25</td><td>48</td></tr>
<tr><td>45</td><td>32</td><td>62</td></tr>
<tr><td>60</td><td>42</td><td>82</td></tr>
<tr><td>75</td><td>52</td><td>102</td></tr>
<tr><td>90</td><td>62</td><td>122</td></tr>
<tr><td>99</td><td>68</td><td>134</td></tr>
</table>
The input filter range is from 0 to 99. A setting of 0 (zero) means that there is no filtering.</td></tr>
<tr><td>CORR FINP1</td><td>If the input sensor has non-linear characteristics, select NON-LINEAR to apply correction factors to the input signal.

Use ▲ or ▼ to select LINEAR or NON-LINEAR.</td></tr>
<tr><td>KFACT1 unit</td><td>This parameter is available for viewing and editing only when the correction type is set to Linear.

The K-factor of the flowmeter is the number of pulses from the flowmeter per unit of volume (or mass). The K-factor cannot be 0 (zero).</td></tr>
</table>

SET ↓	▶ → END PARAMS **INPUTS** OUTPUTS ALARMS COMMS TM/LOG SETUP TEST
NO-PTS FINP1	*This parameter is available for viewing and editing only when the correction type is set to Non-linear.* Enter the number of non-linearity correction points. Press ▲ or ▼ to select a number between 1 and 10 for the number of correction points.
FREQ01 FINP1 *to* FREQ*n*	*This parameter is available for viewing and editing only when the correction type is set to Non-linear.* Enter the frequency for this correction point. The instrument uses linear interpolation between the correction points except that the correction factor for FREQ01 is used from 0 Hz up to FREQ01. Similarly, the instrument maintains the correction factor for the highest frequency setting up to the maximum input frequency. 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.  Enter the lowest correction factor frequency as FREQ01 and proceed up to the highest frequency. You can press the DISPLAY key to skip the non-linear points and go to the next item.
FACT01 FINP1 *to* FACT*n*	*This parameter is available for viewing and editing only when the correction type is set to Non-linear.* Enter the scaling factor for this correction point. The correction factor cannot be 0 (zero).
Analog Input 1	

SET ↓	▶ → END PARAMS **INPUTS** OUTPUTS ALARMS COMMS TM/LOG SETUP TEST
INPUT TEMP AINP1	For this application, Analog Input Channel 1 is assigned to Temperature.
TYPE AINP1	Select the type of analog input source. Press ▲ or ▼ to select 0-5V, 1-5V, 4-20mA, PT100 or DEFAULT.
PT-DEF AINP1	The Default Point is a fixed value that the instrument uses when the Input Type is set to DEFAULT or Default Value On Exception has been ENABLED. You can use the Default value instead of a sensor signal for testing purposes, or if the sensor is faulty. You can set the default value during instrument commissioning so that it is available immediately if you select the Default input type at a later date. Enter the value in the engineering units of assigned variable.
PT-MIN AINP1 PT-MAX	*The Minimum Point and Maximum Point parameters are only for 0-5V, 1-5V and 4-20mA inputs.* Enter the value of the measured parameter that corresponds to the minimum input signal level. The minimum point is commonly referred to as the base value. Enter the value of the measured parameter that corresponds to the maximum input signal level. The maximum point is the same as the base value (set at the minimum point) plus the span value. For example, if the source signal is 4mA for a temperature of 10°C, enter 10 for the minimum point. If the source signal is 20mA for a temperature of 2000°C, enter 2000 as the maximum point.
Analog Input 2	
INPUT PRESS AINP2	For this application, Analog Input Channel 2 is assigned to Pressure.
PRESS AINP2	Select the type of analog pressure sensor. For a gauge type sensor, the instrument adds the atmospheric pressure as defined in the Parameters menu. The pressure will be displayed as absolute or gauge, whichever is selected and indicated with an 'A' or 'G' at the end of the pressure units. However the pressure value when used in calculations, logged or read via serial communications will always be absolute. Press ▲ or ▼ to select ABSOL or GAUGE.

SET ↓	▶ → END PARAMS **INPUTS** OUTPUTS ALARMS COMMS TM/LOG SETUP TEST
TYPE AINP2	Select the type of analog input source. Press ▲ or ▼ to select 0-5V, 1-5V, 4-20mA or DEFAULT.
PT-DEF AINP2	The Default Point is a fixed value that the instrument uses when the Input Type is set to DEFAULT or Default Value On Exception has been ENABLED. You can use the Default value instead of a sensor signal for testing purposes, or if the sensor is faulty. You can set the default value during instrument commissioning so that it is available immediately if you select the Default input type at a later date. Enter the value in the engineering units of assigned variable.
PT-MIN AINP2 PT-MAX	*The Minimum Point and Maximum Point parameters are only for 0-5V, 1-5V and 4-20mA inputs.* Enter the value of the measured parameter that corresponds to the minimum input signal level. The minimum point is commonly referred to as the base value. Enter the value of the measured parameter that corresponds to the maximum input signal level. The maximum point is the same as the base value (set at the minimum point) plus the span value. For example, if the source signal is 4mA for a pressure of 1.00 megaPascals, enter 1.00 as the minimum point. If the source signal is 20mA for a pressure of 5.00 megaPascals, enter 5.00 as the maximum point.
EXCEPT DEFLT	If Default Value On Exception is enabled the instrument will use the default value for the analog input that raised the exception. This will allow calculations to continue, however the exception message will continue to be displayed until the error is rectified or the input type is set to DEFAULT in calibration set mode. Press ▲ or ▼ to select Enable or Disable.

Outputs

SET ↓	▶ → END PARAMS INPUTS **OUTPUTS** ALARMS COMMS TM/LOG SETUP TEST
PULSE OUT*n* or 4-20	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 4-20 mA passive signals. 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. **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 4-20 mA loop circuit.
WIDTH OUT*n*	*The Output Pulse Width is available for viewing and editing only when the assigned variable is a total (pulse output) type.* Pulse output is usually used to drive remote counters. Set the pulse width (in milliseconds) as required by the remote counter. Press ▲ or ▼ to set to: 10, 20, 50, 100, 200 or 500 ms.
PULSE OUT*n*	*The Output Pulse Factor is available for viewing and editing only when the assigned variable is a total (pulse output) type.* The Output Pulse Factor is the scaling factor for the retransmission of the measured total quantity. For example, if "volume" is chosen as an output variable, the engineering unit is cubic metres. Therefore a pulse factor of 1.000 generates one pulse for 1 m^3. Similarly, a pulse factor of 3.000 generates one pulse for 3 m^3. For more information, see **Output Pulse Factor** on page 40. The output pulse factor cannot be 0 (zero).

SET ↓	▶ → END PARAMS INPUTS **OUTPUTS** ALARMS COMMS TM/LOG SETUP TEST
PT-MIN OUT*n* PT-MAX OUT*n*	*The Output Minimum Point and Maximum Point are available for viewing and editing only when the assigned variable is a rate (4-20 mA output) type.* The output minimum value corresponds to the 4 mA point and the output maximum value corresponds to the 20 mA point. Setting the output range differently from the input range enables the instrument to amplify the input signal. You can drive a chart recorder that "zooms in" on a specified range of values instead of displaying the full operating range of the transducer. For example, if the minimum point is set to 30 m^3/min and the maximum point is set to 100 m^3/min, the 4 to 20 mA range would reflect the volumetric flow rate range of 30 to 100 m^3/min. At rates above the maximum and below the minimum points, the output remains at 20 mA and 4 mA respectively.

Output Pulse Factor

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

The maximum pulse output frequency is determined by:

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

The minimum pulse factor required is determined by:

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

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

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

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

Alarms

There are four alarm relays that can be assigned to rate variables such as temperature, 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 has normally closed contacts that open when the instrument displays any error message as listed in **Error Messages** on page 49, or if there is a loss of power to the instrument.

SET ↓	▶ → END PARAMS INPUTS OUTPUTS **ALARMS** COMMS TM/LOG SETUP TEST
RELAY ALRM*n*	Select a rate variable to assign to the alarm relay. **Note:** If the alarm type is set to “equipment alarm”, this relay assignment setting is ignored. Press ▲ or ▼ to select the variable that is required as an alarm.
TYPE ALRM*n*	The options available for alarm types are as follows: • HI-NO — High Alarm, Normally Open contacts • HI-NC — High Alarm, Normally Closed contacts • LO-NO — Low Alarm, Normally Open contacts • LO-NC — Low Alarm, Normally Closed contacts • AL-NC — Equipment Alarm, Normally Closed contacts Press ▲ or ▼ to select the type of alarm required.

SET ↓	▶ → END PARAMS INPUTS OUTPUTS **ALARMS** COMMS TM/LOG SETUP TEST
POINT ALRM*n*	*The Alarm Setpoint is available for viewing and editing only when the alarm type is a high or low alarm.* The Alarm Setpoint is the value (in engineering units of assigned variable) at which the alarm condition occurs and therefore the alarm is on. If this alarm assignment is for a high alarm, the setpoint value must be higher than the low alarm setpoint. Similarly, if this alarm assignment is for a low alarm, the setpoint must be lower than the high alarm setpoint.
HYST ALRM*n*	*The Alarm Hysteresis is available for viewing and editing only when the alarm type is a high or low alarm.* Alarm hysteresis loops occur when the alarm toggles continuously on and off when the process variable is close to the setpoint. 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). 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). 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.

Communications

The instrument has three communication ports:

- **RS-232 Port** - A 9-pin female connector on the rear panel of the instrument.
- **Infra-red Port** - Located on the front panel, below the status indicators.
- **RS-485 Port** - (Advanced option only) Terminals on the rear panel.

SET ↓	▶ → END PARAMS INPUTS OUTPUTS ALARMS **COMMS** TM/LOG SETUP TEST
PROTOC RS232 RS485 INFRA	The Communications Protocol for each communication port can be set to either ASCII or Modbus RTU. A protocol cannot be assigned to more than one port at a time. If a port is not being used, set the protocol to NONE. For the selected port, press ▲ or ▼ to select NONE, RTU, or ASCII.
BAUD RS232 RS485 INFRA	The Baud setting is the speed of the communication port in data bits per second. The baud rate of the instrument must match the baud rate of the communication device that the instrument is connected to. Use ▲ or ▼ to select 2400, 4800, 9600 or 19200 baud.
PARITY RS232 RS485 INFRA	The Parity bit offers a small amount of error checking, to help detect data corruption that might occur during transmission. The parity bit setting of the instrument must match the parity bit checking of the communication device that the instrument is connected to. Press ▲ or ▼ to select EVEN, ODD, or NONE.
S-BITS RS232 RS485 INFRA	The Stop bit indicates the end of a transmission. Stop bits can be 1 or 2 bit periods in length. The stop bit setting of the instrument must match the stop bit setting of the communication device that the instrument is connected to. Press ▲ or ▼ to select 1 or 2 stop bits.
RTU ADDR	The Modbus RTU protocol address must be in the range of 1 to 247. When multiple instruments (slaves) are connected to one communication device (master), each assigned address must be unique. **Note:** The master device uses the RTU address 0 (zero) for broadcasting to all connected slave units.

SET ↓	▶ → END PARAMS INPUTS OUTPUTS ALARMS **COMMS** TM/LOG SETUP TEST
ASCII ADDR	The ASCII protocol address identifies each communicating device. 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.
FLASH PORT	The Flash Driver Port assignment defines the communication port for downloading software into the instrument. The default setting of this assignment is the RS-232 port. Press ▲ or ▼ to select RS-232, RS-485, or INFRA.

Time Settings and Data Logging

Instrument Clock

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

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

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

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

Data Logging

The instrument can store up to 100 log entries of the first ten main-menu variables. These logs can all be for one time interval, or shared with other timescales. For example, you can specify 40 hourly logs, 30 daily logs, 15 weekly logs, 10 monthly logs and 5 yearly logs.

SET ↓	▶ → END PARAMS INPUTS OUTPUTS ALARMS COMMS **TM/LOG** SETUP TEST
DATE FORM	Clock Date Format The European date format is: dd/mm/yyyy or (Day-Month). The American date format is: mm/dd/yyyy or (Month-Day). Press ▲ or ▼ to select DAY-M or M-DAY
CLOCK YEAR	The Clock Year defines the current year for the real-time clock.
CLOCK M-DAY	The Clock M-DAY setting defines the current month and date for the real-time clock. This parameter is programmed in Month-Day format for both European and American date formats.
CLOCK H-MIN	The Clock H-MIN setting is the current time in hours and minutes for the real-time clock.
HOUR LOGS	Set the number of Hourly Logs to record. The hourly log entry occurs at 00 minutes each hour.
DAY LOGS	Set the number of Daily Logs to record. The daily log entry occurs at 00 hours and 00 minutes each day.
WEEK LOGS	Set the number of Weekly Logs to record. The weekly log entry occurs at 00 hours and 00 minutes each Monday.
MONTH LOGS	Set the number of Monthly Logs to record. The monthly log entry occurs at 00 hours and 00 minutes on the first day of the month.
YEAR LOGS	Set the number of Yearly Logs to record. The yearly log entry occurs at 00 hours and 00 minutes on the first day of the year.
RESET LOGS	Reset the logged data. You may need to reset (clear) the logged data if you change the time/log settings. Press ▲ or ▼ to select YES, then press the SET key. The instrument makes three beeps to confirm the reset command.

General Setup Parameters

SET ↓	▶ → END PARAMS INPUTS OUTPUTS ALARMS COMMS TM/LOG **SETUP** TEST
DEFAULT TOTAL	The instrument displays the default Total when the user presses the **TOTAL** key. If the display timeout is enabled, the instrument displays the default Total when there is no user action for the period of the display timeout period. Press ▲ or ▼ to select the default total display.
SUPPLY VOLT	The instrument provides a power-limited supply for external transducers. Press ▲ or ▼ to set the transducer supply voltage between 8 and 24 volts DC as required.
T-OUT MODE	If the Display Timeout mode is enabled, and there is no user activity for the defined timeout period, the display panel returns to the default display. This function is useful for the following reasons: • to return the display to a preferred variable after the user has finished reading other information, • to cancel the calibration mode and return to the default display if the user does not exit from the calibration mode for any reason. Press ▲ or ▼ to select the display timeout function as follows: • **DISABLE** - Timeout is completely disabled. • **EN DISP** - Timeout is enabled during Normal mode and Calibration View mode. • **EN EDIT** - Timeout is enabled during Calibration Set mode. • **EN ALL** - Timeout is enabled for all modes.
T-OUT SEC	The Display Timeout period defines the delay for the Display Timeout mode if it is enabled. The display timeout period can be from 10 to 99 seconds.
RESET MODE	The Totals Reset mode can be configured to reset the non-accumulated totals to zero. Press ▲ or ▼ to select the reset mode as follows: • **NONE -** The user cannot reset the non-accumulated totals. • **INSTANT** - When the user presses the **RESET** key, the instrument resets all non-accumulated totals. • **DELAYED -** When the user presses the **RESET** key and holds it for two seconds, the instrument resets all non-accumulated totals.

SET ↓	▶ → END PARAMS INPUTS OUTPUTS ALARMS COMMS TM/LOG **SETUP** TEST
RESET ACCUM	The Reset Accumulated Totals function clears all of the accumulated totals and the non-accumulated totals. Press ▲ or ▼ to select YES, then press the SET key. The instrument makes three beeps to confirm the reset command.
DISPL TAGS	The Display Tags option determines whether the instrument displays the default display tags or the user-defined tags. The display tag setting also defines whether the instrument displays the default error and warning messages, or the user-defined messages. **Note:** The user-defined tags can be entered into the instrument only by the manufacturer or the distributor. Press ▲ or ▼ to select the Display Tags option as follows: • **DEFAULT** - the instrument displays the default (English) tags • **USER** - the instrument displays the user-defined tags.
BACK-L T-OUT	If the backlight timeout is enabled, and there is no user activity (any keys pressed) for a period of 10 seconds, the display backlight switches off to save power. The backlight switches on when a key is pressed. Select the backlight timeout mode as required. Press ▲ or ▼ to select Enable or Disable.

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 ↓	▶ → END PARAMS INPUTS OUTPUTS ALARMS COMMS TM/LOG SETUP **TEST**
FINP1 Hz	The frequency of the input to FINP1 is displayed in Hertz.
AINP1 *units*	The units are displayed according to the calibration setup for this analog input. This input is not visible if the input type is set to Default.
AINP2 *units*	The units are displayed according to the calibration setup for this analog input. This input is not visible if the input type is set to Default.

SET ↓	▶ → END PARAMS INPUTS OUTPUTS ALARMS COMMS TM/LOG SETUP **TEST**
OUT1 STATE *to* OUT2	You can control the state of the outputs. Press the ▲ or ▼ keys to set the output state as follows: • **PROCESS** - the output depends on the current values of the inputs and the calculations that the instrument performs. For a pulse output, such as a total, the output produces a pulse train as follows: • **ON** - a pulse train with a pulse width as set for the particular output in the Outputs menu. • **OFF** - no output. For a 4-20 mA output, such as a rate, the output is as follows: • **HI** - the output is set to 20 mA. • **LO** - the output is set to 4 mA.
ALRM1 STATE *to* ALRM4	You can control the state of the alarms. Press the ▲ or ▼ keys to set the selected alarm as follows: • **PROCESS** - the alarm condition operates according to the current values of the inputs and the alarm settings as programmed. • **OPEN** - the alarm output contacts are set to “open”. • **CLOSED** - the alarm output contacts are set to “closed”.
SUPPLY V	You can display the actual DC output supply voltage, which may help with troubleshooting. If the actual supply voltage is lower than the preset value (refer to **General Setup Parameters** on page 46) it may indicate that the output is overloaded.

System Messages

The instrument displays messages for defined events and fault conditions.

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

Error Messages

Failure of Analog Input Sensor

If there is a failure of an analog input sensor for a process parameter such as temperature or pressure, the instrument sets the value of that parameter to 0 and displays the relevant error message. The input sensor and connections need to be inspected and may require replacement.

The instrument also sets the results of calculations that depend on the failed input(s) to 0. For example, if the temperature sensor fails, the instrument displays a temperature reading of 0 and the calculated energy flow as 0. However, if the flow sensors are still functioning, the instrument continues to calculate and display volume flow.

Default Value on Exception

If Default Value On Exception has been enabled in the INPUTS section of calibration, the default value will automatically be used so that all calculations can continue. The error message will still continue to scroll across the display until the fault is corrected at which point the calculations will revert to using the live input.

Override Error Condition

While a fault is being rectified on an analog input for a process parameter, an operator with calibration access can set the Analog Input Signal Type to DEFAULT and the Analog Input Default Point to a typical process value. If there are no other faults, the instrument continues to operate by using the default value.

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

Error Messages	**Description**
CPU Card Failure	There are failed components on the CPU card and technical support is required.
Power Supply is Low	The input and/or output power supply voltage is too low, ensure that: (a) input power supply voltage is within the specified range (b) output power supply is not overloaded.
Temperature Sensor Failure	The temperature sensor (analog input 1) has failed. To deactivate the error, the Analog Input Signal Type can be set to DEFAULT to use a programmed default value instead of the sensor signal.
Pressure Sensor Failure	The pressure sensor (analog input 2) has failed. To deactivate the error, the Analog Input Signal Type can be set to DEFAULT to use a programmed default value instead of the sensor signal.

Error Messages	Description
Invalid Reference Parameter	The reference parameter is outside of the allowed range. Reference temperature and pressure (specified in the Parameters menu) should be within the AGA-8 limits.
Temp/Pressure is Out of Range	The temperature and/or pressure inputs are outside of the allowed calculation range.
New/Failed Battery - Set Time	The real-time clock has lost the correct time because the battery has failed, or there is a new battery. Set the current time and date (in the TM/LOG menu) to clear the error message and to continue data logging at the correct times. **Note:** The instrument can continue operating with a failed battery, but the correct time will be lost if there are interruptions to the power supply.

Warning Messages

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

Warning Messages	Description
Value Has Been Set to Default	You have entered an invalid value for a parameter. Therefore, the instrument has set the default value.
Over Total Limit - Maximum Set	You have exceeded the maximum number of logging entries for the combined time bases. The instrument has set the current log setting to the remaining maximum number.
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.

Chapter 6
Communications

Overview

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

Hardware Interconnection

The instrument has three communication ports:

- RS-232 port on the rear panel (DB9 female connector)
- RS-485 port on the rear panel (advanced option only)
- Infra-red port on the front panel

The appropriate interface and protocols are selected during calibration.

RS-232 Port

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

Computers use either a DB9 or a DB25 connector, and the connections to each type are shown in Figure 15.

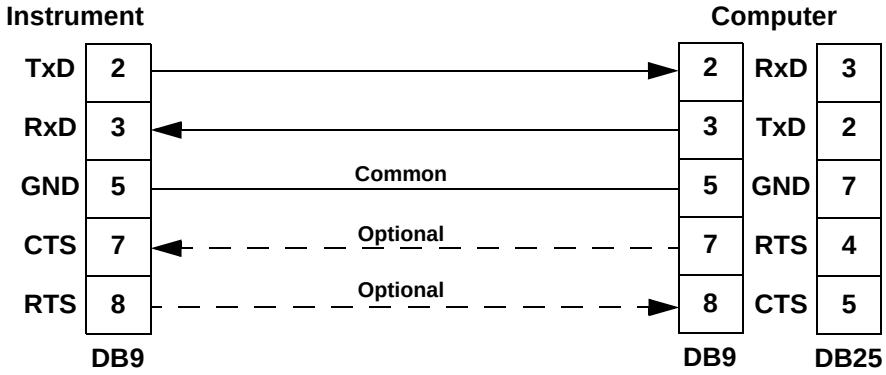


Figure 15 RS-232 Cable Connections to a Computer

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 (Advanced Option only)

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

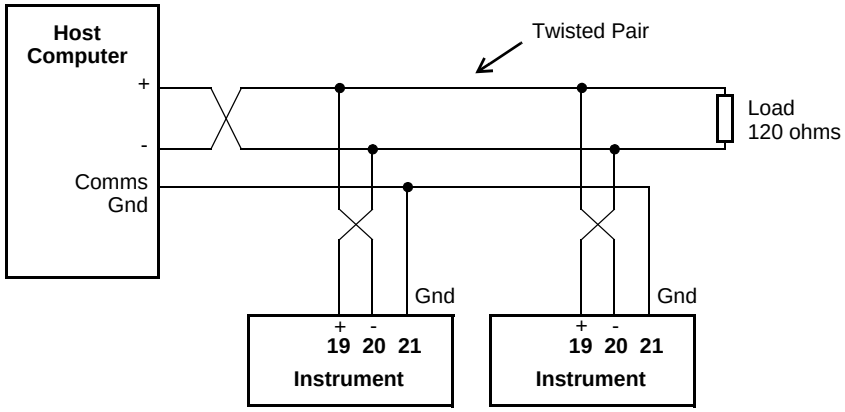


Figure 16 RS-485 Connections

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

Any of the ports on the instrument can use the communication protocols as follows:

- **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.

Note: If a port is not being used, its protocol should be set to NONE in the instrument configuration as described in **Communications** on page 42.

A protocol cannot be assigned to more than one port. Therefore if you assign Modbus RTU protocol to the RS-485 port, you cannot assign it to the RS-232 port also. The RS-232 port can now only use the ASCII protocol or NONE.

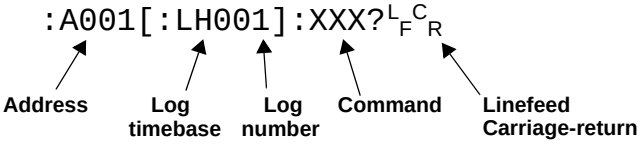
Simple ASCII Protocol

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 an request to the instrument is as follows:



Each request must include the address and command portions. The brackets [ ] indicate an optional element and is not an essential 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 42 for setting the instrument address.

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

Log Timebase and Number

The log timebase and number enables a communicating device to retrieve data that the instrument has logged.

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.

Note: 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 timebase of the log is as follows:

- LH - hourly log
- LD - daily log
- LW - weekly log
- LM - monthly log
- LY - yearly log
- LE - last edit log

The number of the log entry is the same as shown on the front panel of the instrument. For example, a request for LH003 would return the data for the log entry two hours prior to the most recent hourly log entry. For example, if the current time is between 9:00 am and 10:00 am, the most recent hourly log LH001 was recorded at 9:00. Therefore, LH002 is for 8:00 and LH003 is for 7:00. Of course, after 10:00 am in this example, LH003 becomes the 8:00 log.

Instrument Responses

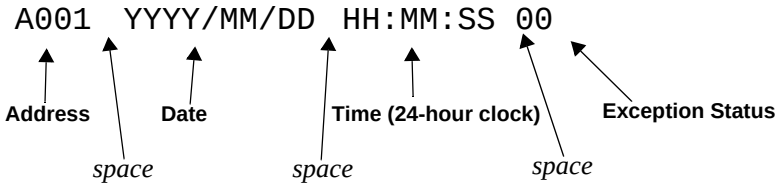
The instrument response time to any enquiry is not more than 300 ms. The responses from the instrument are in the following format:

HEADER$^{L}_{F}{}^{C}_{R}$
DATA$^{L}_{F}{}^{C}_{R}$
DATA$^{L}_{F}{}^{C}_{R}$
.
.
.
DATA$^{L}_{F}{}^{C}_{R}$
$^{L}_{F}{}^{C}_{R}$

The components of the response message are as follows:

Header

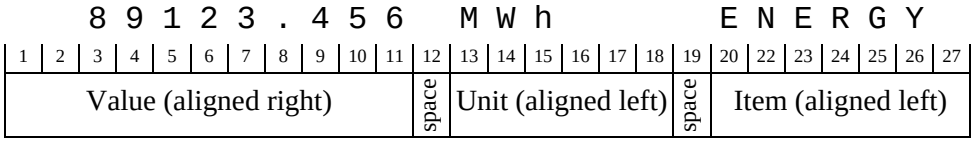
The format of the response header from the instrument is as follows:



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 62.

Data

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



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.

```
:A001:RVA? LF CR
```

The following is an example of a hypothetical instrument response. Refer to **Main Menu Variables** on page 3 for the list of variables that would be returned for this application.

```
A001  2002/03/14  18:25:00  00 LF CR
        6.116  MWh       ENERGY  LF CR
       16.573  MW        POWER   LF CR
     1320.530  m3        VOLUME  LF CR
       58.300  m3/M      V-FLOW  LF CR
     7627.117  KG        MASS    LF CR
      344.460  KG/M      M-FLOW  LF CR
      230.000  DEG  C    TEMP    LF CR
        1.260  MPA       PRESS   LF CR
        0.174  m3/KG     SP-VOL  LF CR
     2886.760  KJ/KG     SP-ENT  LF CR
LF CR
```

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

```
:A001:RVD? LF CR
```

The instrument response would be similar to the following:

```
A001  2002/03/14  18:25:00  00 LF CR
      126.455  m3        VOLUME  LF CR
       20.437  m3/M      V-FLOW  LF CR
LF CR
```

Log Request

The log request asks the instrument how many logs it stores in the particular timebase. These are the values described in **Time Settings and Data Logging** on page 44.

Command	Description
:RLH?	Return the number of hourly logs
:RLD?	Return the number of daily logs
:RLW?	Return the number of weekly logs
:RLM?	Return the number of monthly logs
:RLY?	Return the number of yearly logs

Log Response Example

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

```
:A001:RLH? LF CR
```

The instrument response would be similar to the following:

```
A001  2002/03/14  18:25:00  00 LF CR
24 LF CR
LF CR
```

Clear Data Request

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

Command	Description
:RCL?	Clear the timebase 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:

```
:A001:RCL? LF CR
```

The instrument response would be similar to the following:

```
A001  2002/03/14  18:25:00  00 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:

```
:A001:RIG? LF CR
```

The following is an example of a hypothetical instrument response:

```
A001  2002/03/14  18:25:00  00 LF CR
515       MODEL    -10-F- LF CR
SC01      INPUT    F-TP-- LF CR
SC01      VERS    0101.001 LF CR
CUSTOM    VERS      000001 LF CR
SERIAL    No        123456 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 request variables 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 list describes the addresses and meaning of the data registers in the instrument. The floating point values are expressed in the engineering units that were selected for the variables when the instrument software was downloaded.

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

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

Current and Logged Process Data

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

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

Register	Name	Comments	Read Only or Read/Write	Type
1	Volume	Process Variables (Totals are the Accumulated values)	R	FP*
3	Volume Flowrate		R	FP
5	Corrected Volume		R	FP
7	Corrected Flowrate		R	FP
9	Heat		R	FP
11	Heat Flowrate		R	FP
13	Mass		R	FP
15	Mass Flowrate		R	FP
17	Temperature		R	FP
19	Pressure (absolute)		R	FP
21	Compressibility Factor		R	FP
23	Reserved		R	FP
25	Reserved		R	FP
27	Reserved		R	FP
29	Reserved		R	FP
31	Year	Date/Time Stamp	R	I†
32	Month		R	I
33	Date		R	I
34	Hour		R	I
35	Minute		R	I
36	Second		R	I
37	Log Timebase	00 - hourly 01 - daily 02 - weekly 03 - monthly 04 - yearly 05 - last edit of calibration	R/W	I
38	Log Number	0 to 99 If set to 0, current variables are retrieved	R/W	I
39	Clear Data	01 - clear logs	W	
40	Reserved		R/W	

* FP = Floating Point (4 bytes)

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

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

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

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

Instrument Exception Status

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

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

* I = Integer (2 bytes)

Instrument Parameter Registers

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

Register	Name	Comments	Read Only or Read/Write	Type
42	Parameter Source	0 = User 1 = Modbus	R	I*
43	Logic Inputs	0 to 15 Binary representation of logic inputs B0 = 0/1 (LSB) input 1 activated/deactivated B1 = 0/1 input 2 activated/deactivated B2 = 0/1 input 3 activated/deactivated B3 = 0/1 input 4 activated/deactivated	R	I
44	Operation Mode	Representation of operation mode 0 = Idle/Local Idle state	R	I
45	Reserved			
51 to 97	Calibration parameters	This bank of registers give access to the gas property value(s) in the same order as described within **Parameters** on page 32. The accessible values are those items immediately following the parameter items that sets the access as either USER or RTU.	R if 42 = 0 R/W if 42 = 1	FP

* I = Integer (2 bytes)

Printer Communications

The current version of the instrument does not provide a direct printer output.

Appendix A
Glossary

AGA-8 American Gas Association AGA-8 is the equation to predict the compressibility of natural gas mixtures with higher inert contents (up to 50% N_2 and /or CO_2) and higher pressure and temperature than the NX-19 equation is used for.

ASCII 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.

Absolute Pressure Absolute Pressure = Atmospheric Pressure + Gauge Pressure.

It is the combined local atmospheric pressure and the gauge pressure. All calculations are based on absolute values for pressure. Some sensors can directly measure the absolute pressure value while others measure gauge pressure. Pressure can be displayed as absolute or gauge and is indicated with an ‘A’ or ‘G’ appended to the pressure units of measure.

Atmospheric & Gauge Pressure Some sensors only measure gauge pressure, in this case the atmospheric pressure must be programmed to determine the absolute value. The atmospheric value is affected by the altitude of the installation. The atmospheric pressure default is 101.325 kPa (14.696 psia) which is the standard value at sea level.

IrDA The Infra-red Developers Association is a group of computer and software manufactures who have agreed on a format for communication among infrared devices.

K-factor 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.

Modbus RTU 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.

Normal Conditions

Normal conditions are defined as:

- 0°C (273.15 K) and 101.325 kPa
- 32°F (491.67°R) and 14.696 psia.

A flow rate at normal conditions is indicated with an ‘N’ in the front of the corrected volume units of measure. Compare with *Standard conditions*.

Normalised Input

A normalised input ranges from 0 to 1.000. For 4-20 mA input, the signal is set to 0 at 4 mA and the signal is set to 1.000 at 20 mA.

NPS

Namur Proximity Switch.

NX-19

A set of equations for calculating compressibility of natural gas as a function of temperature, pressure and gas composition.

Passive Output Signal

Requires an external power supply.

RTD

Resistance Temperature Device

Standard Conditions

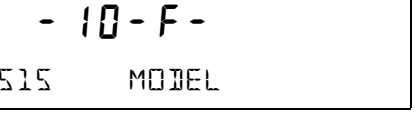
Standard condition are defined as:

- 15°C (288.15 K) and 101.325 kPa, or
- 59°F (518.67°R) and 14.696 psia.

A flow rate at standard conditions is indicated with an ‘S’ in the front of the corrected volume units of measure. Compare with *Normal conditions*.

Appendix B
Model Numbers

Product Codes

Model	Supplementary Code					Description
515 .					**-** GN01	
Enclosure	1					Panel mount enclosure
	2					Field mount enclosure (not yet available)
	3					Explosion proof Ex410 with metric glands
	4					Explosion proof Ex410 with NPT glands
Output Options		0				**Basic**: – 9 way DB RS-232 serial port and 2 relays
		1				**Advanced** - also includes RS-485 port, 4 relays, 2 isolated 4-20mA or pulse outputs, 4 logic inputs and time-based logging
Extra Options			0			None
			1			Reserved
Power Supply				E		For 220/240VAC
				A		For 110/120VAC
				D		For DC power only 12-28VDC
Display Panel Options					F	Fully optioned (with backlight, LCD backup and Infra-Red comms port)
PCB Protection					C	**Conformal coating** - required for maximum environmental operating range. Recommended to avoid damage from moisture and corrosion.
					N	**None** - suitable for IEC standard 654-1 Climatic Conditions up to Class B2 (Heated and/or cooled enclosed locations)
Application Pack Number					GN01	Defines the application software to be loaded into the instrument
For example: Model No. 515.110EFC Displayed on the 500 Series as: (only h/w that affects the operation is represented)						

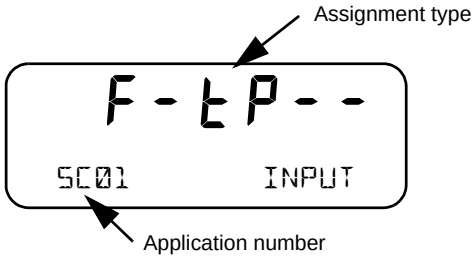
Note: Example full product part number is 515.110EFC-GN01 (This is the number used for placing orders).

Custom Version Codes

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

Application Information Code

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



The Application Information code is returned as part of a General Instrument request (as described in **Instrument Information Request** on page 58).

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:

FINP1	FINP2	AINP1	AINP2	AINP3	AINP4
X	X	X	X	X	X

The codes are as follows:

- - - not used in this application
- A - indicates a generic analog input such as 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-tP-- 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.

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