FLOW COMPUTER
MODEL 405Q

CE

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CONTENTS

1. INTRODUCTION

The Model 405Q Flow Computer is designed for high accuracy flow measurement applications, where frequency or pulse producing flowmeters such as turbine, positive displacement or vortex meters are used.

The Flow Computer includes such features as:

- SINGLE or QUADRATURE pulse inputs.
- NON-LINEARITY CORRECTION.
- TICKET PRINTING or COMPUTER interface options.
- RE-TRANSMISSION OF FLOW via a scaled pulse or a 4-20mA output.

The Model 405Q is ideally suited to custody transfer applications where high accuracy and signal integrity is required.

The instrument is fully programmable, with all calculation constants set via the front panel switches and stored permanently in a non-volatile memory.

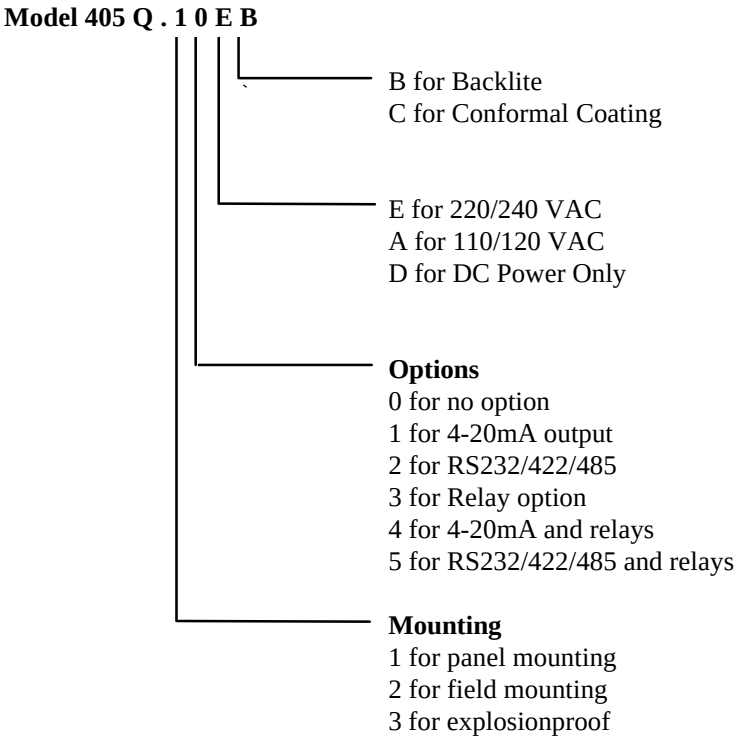
This instrument conforms to the EMC-Directive of the Council of European Communities 89/336/EEC and the following standards:

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 Section 7.1 must be followed.

1.1 MODEL NUMBER DESIGNATION

The Model number of an instrument describes which input and output options are installed and the AC mains voltage rating.



The Model number of the instrument is displayed on first entering the Calibration Mode (see Section 5).

2. SPECIFICATION

General

Display:	6 digit LCD. 0.7" (17.8mm) high digits.
Display Update Rate:	0.25 seconds.
Transducer Supply:	8-24VDC field adjustable. 50mA maximum.
Power Requirements:	11.5 to 28.5 volts DC. 60mA typical current (no options). AC Mains: Set internally to 95 - 135 VAC or 190 - 260 VAC.
Operating Temperature:	0 to 55°C standard.
Dimensions:	5.7" (144mm) wide x 2.8" (72mm) high x 7.0" (178mm) deep.
Cutout**:**	5.5" (139mm) wide x 2.6" (67mm) high**.**

Frequency Input

Frequency Range:	Minimum:	0.25Hz on Rate. 0Hz on Total.
	Maximum:	10KHz with a single input. 2.5KHz with a quadrature input.
Input Circuits:	Will accept most sine logic and proximity switch inputs (see section 6.1).	
Scaling Range:	0.1000 to 50,000.	

Relay Outputs

Maximum Switching Power:	1250VA.
Maximum Switching Voltage:	250VAC, 30VDC.
Maximum Switching Current:	5 Amps.

6 Specification

4-20mA Output

Resolution:	10 bits.
Accuracy:	Better than 0.05%.
Maximum Load:	500 ohms internally powered. 950 ohms from 24VDC.
Isolation:	Output is isolated.

Pulse Output

Pulse Width:	10mSec (negative going pulse).
Maximum Duty Cycle:	49 pulses per second.
Output:	An open collector transistor will sink 100mA.
Scaling:	The pulse output is scaled and outputs one pulse each time the accumulated total increments.

Non-linearity Correction

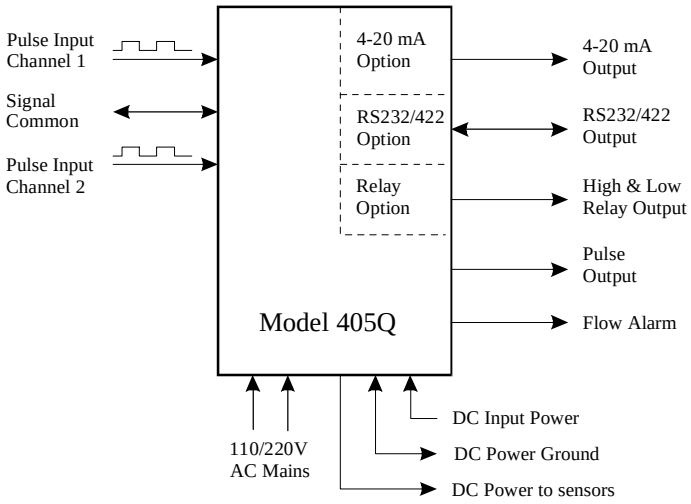
Number of Points:	10 correction points maximum.
Correction between points:	Linear interpolation used.

3. OPERATION

The Model 405Q uses a low power CMOS microprocessor to perform all control functions and calculations.

The instrument is fully programmable with all operating parameters and calculation constants user programmable. (See Section 5 entitled "Calibration" for information on programming.) All parameters and constants are stored in a non-volatile memory which retains data without battery backup for a minimum of 10 years.

A block diagram of the instrument is shown below.



A DIL switch on the rear panel enables the frequency input circuit to be set to interface with a wide range of flowmeters, including turbine flowmeters and flowmeters with Namur type sensors.

3.1 FRONT PANEL OPERATION

The display will normally show the Rate or resettable Total, as selected by the RATE or TOTAL keys on the front facia. An LED in the key panel will light to indicate which function is currently displayed.

The DISPLAY key can be used to display the Accumulated Total. On the first press of the DISPLAY key, the display shows ACCTOT for one second followed by the actual total. The Accumulated Total continuously totalises the flow and is not resettable from the front panel.

All values of rate and total will be compensated for flowmeter non-linearity, if this function is selected.

On reaching the maximum displayed total, all totals will roll over to zero and continue totalising. If, at any time, power is lost or the instrument is switched off, the totals will be stored in the non-volatile memory. When power is switched back on to the instrument, the stored totals will be recalled from memory and the totals will be incremented from the last values.

3.2 SINGLE AND QUADRATURE INPUTS

In most industrial flowmetering applications, a frequency producing flowmeter has only a single output.

However, in many custody transfer applications, it is a requirement that the flowmeter has two outputs so that the integrity of the signal can be assured. This usually requires a turbine meter to have two coils, or a positive displacement meter to have two pulse units.

The Model 405Q can interface to flowmeters fitted with two sensors and connections to the flowmeters are outlined in Section 6.1.

The quadrature input has two functions.

1 **To detect a difference in the number of pulses from each input during delivery.**

   The instrument will alarm if the pulse difference (since reset) exceeds 1 in 1000 pulses. When an alarm condition exists the totals will cease counting and will freeze at the last total prior to the alarm.

   On detection of the alarm condition, the alarm output on terminal 7 will go low (energise) and the display will cease counting. The output can be used to shutoff the flow or to warn the operator. The display will also periodically flash the error message, ERR 13.

   The alarm condition is reset by pressing the DISPLAY key.

2 **Bi-directional Flow.**

   The 405Q has the ability to detect forward and reverse flow. The inputs must be connected with channel 1 being the 90° flow signal and channel 2 being the 0° signal. For forward/reverse detection to function correctly, there must be clear definition of the input signals.

3.3 CALCULATION OF RATE AND TOTAL

3.3.1 Frequency Input

The flowrate, R, is calculated as follows:

$$R = \frac{f \times H}{S}$$

where f is the input frequency in Hz.
H is the timebase of rate and is 1 for seconds, 60 for minutes, 3600 for hours and 86,400 for days.
S is the Scaling Factor.

The Scaling Factor, *S*, is equal to the K-factor of the flowmeter expressed in pulses per unit volume.

The user programs the Scaling Factor and selects the timebase during the Calibration procedure as detailed in Section 5 of this manual.

When non-linearity correction is programmed, up to 10 scaling factors are programmed to cover different frequency ranges. The instrument will then automatically select the correct scaling factor to be applied at the measured frequency.

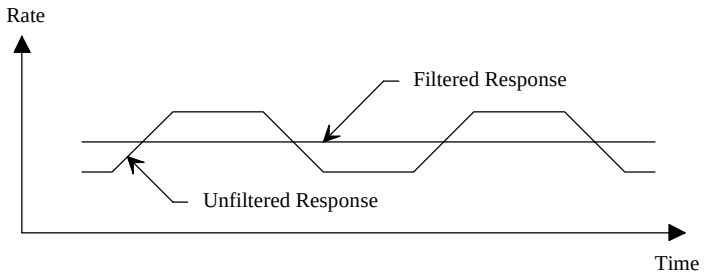
3.3.2 Filtering

Frequency fluctuations caused by pulsating flow through a flowmeter, often makes the Rate impossible to read with any precision.

The Flow Computer has a digital filter which will average out these fluctuations and enable the Rate to be read to four digit accuracy. The degree of filtering is fully programmable which means that highly accurate and stable readings can be obtained without excessive lag.

When the Rate is retransmitted via the 4-20mA output, the filtering will also average out any fluctuations on the output.

The diagram below shows a pulsating signal input together with the effect of filtering.



As a guideline to the degree of filtering to be used, the following table shows the response to a step change in input. The value, A, is the filter constant which is programmed during the Calibration routine. The times for the display value to reach 90% and 99% of full swing are given in seconds, for different values of A.

A	90%	99%
1	0	0
2	1	2
4	2	4
6	3	6
10	5	11
15	8	17
20	11	22
25	14	28
35	20	40
45	25	51
60	34	69
75	43	86
90	52	103
99	57	113

Table 1 - Response to a step Input (in seconds).

Note that if A is set to 1 there is no filtering of the input signal.

3.4 TOTAL CONVERSION

The Total Conversion feature enables the rate to be displayed in one engineering unit (eg. gallons/minute) and the totals to be displayed in another engineering unit (eg. barrels).

The Scaling Factor is always programmed in the unit relating to Rate, and the Total Conversion constant is a division factor which can be used to convert the totals to the different unit. The Total Conversion factor affects the net, accumulated and gross totals, and is limited between 0.01 and 2000.

For Example.

If the Rate is required in gallons per minute:

1. The Scaling Factor would be programmed as pulses per gallon
2. The timebase would be programmed as minutes

If the Totals are required in barrels:

3. The Total Conversion factor is programmed as 42 (there are 42 gallons in a barrel). All totals will now totalise in barrels.

Some common units are given below together with the Total Conversion constant (TOTCON) which should be programmed.

Rate*	Totals	TOTCON
Gallons (US)/	Barrels (oil)	42.000
Litres/	Kilolitres	1000
ml/	Litres	1000
Mgallons/	Acre-feet	0.32587

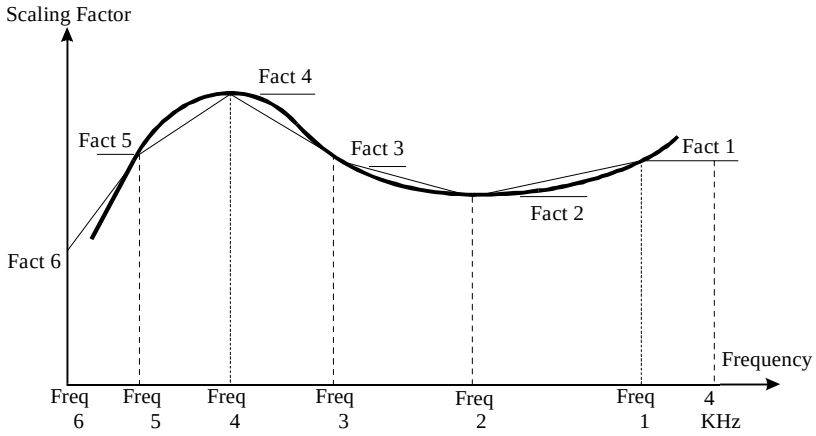
* Units per second, minute, hour or day. The timebase is programmed separately during Calibration.

3.5 NON-LINEARITY CORRECTION

Non-linearity correction enables the instrument to correct for known non-linearities in the flowmeter.

Up to 10 frequencies and scaling factors can be programmed. Data on the flowmeter non-linearity can usually be supplied by the flowmeter manufacturer in the form of a Calibration Certificate, and is the result of individual tests on a flowmeter over a range of flowrates. The Certificate will list a number of flowrates or frequencies with the measured K-factor (eg. pulses per gallon or litre) at each flowrate.

The following diagram graphs the change in scaling factor with frequency for a hypothetical flowmeter. The heavy black line represents the actual scaling factor of the flowmeter, while the light black line is the approximation used in the instrument.



Linear Interpolation is used between points on the curve, except for Factor 1 which maintains a constant value between Frequency 1 and the maximum input frequency.

During Calibration, the program requires the user to input a frequency and the Scaling Factor (K-factor of the flowmeter) at up to 10 points on the curve. Generally these points will correspond to those shown on the Certificate.

If any frequency is set to 0Hz (Frequency 6 in the preceding example), then the program will require no further correction points to be programmed. Hence, the user can program any number of correction points up to a maximum of 10. Note that if all 10 correction points are required, then Frequency 10 will automatically be assigned the value of 0Hz.

3.6 THE OUTPUT PULSE AND FLOW ALARM

An **OUTPUT PULSE** is available on terminal 10 for driving remote counters and produces a pulse each time the Accumulated Total increments by one digit. For example, if the Accumulated Total has a resolution of 0.01 gallons, a pulse is produced each 0.01 gallons.

The pulse is a current sinking pulse of approximately 10mSec produced by an open collector transistor and can sink up to 100mA. The maximum pulse rate is limited to 49 pulses per second and the resolution on the accumulated total must be set so that the accumulated total increments at less than 49 counts per second.

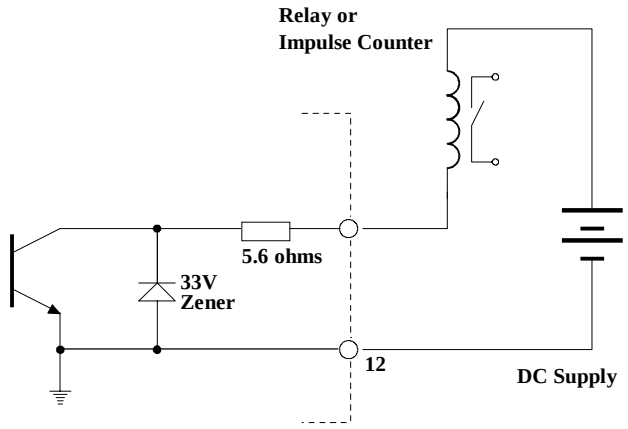
Note that due to the uneven pulse output spacing on this output, the pulse output cannot be used to drive rate indicators.

The **FLOW ALARM** uses an identical circuit to the Output Pulse, and is on terminal 7.

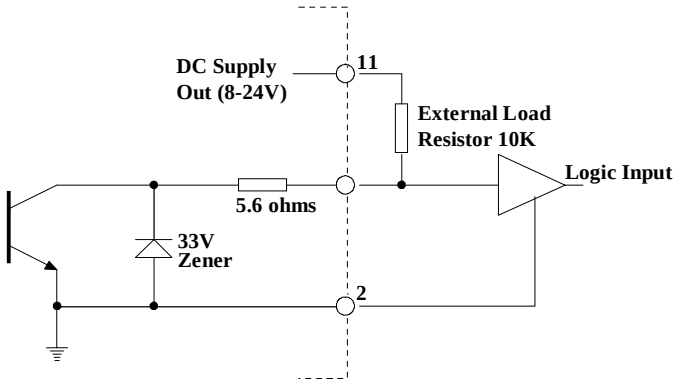
The Flow Alarm is used by the Quadrature Input, if selected, and will output an error signal if there is a difference between the input pulses as described in Section 3.2.

The Flow Alarm output will switch "on" (ie the signal goes low) whenever an alarm condition exists. The Alarm will switch "off" (ie the signal goes high) when the alarm is reset by pressing the DISPLAY key.

Connection of Output Pulse and Flow Alarm are as follows:



Driving an External Relay or Impulse Counter



Driving a Logic Input such as a PLC or Electronic Counter

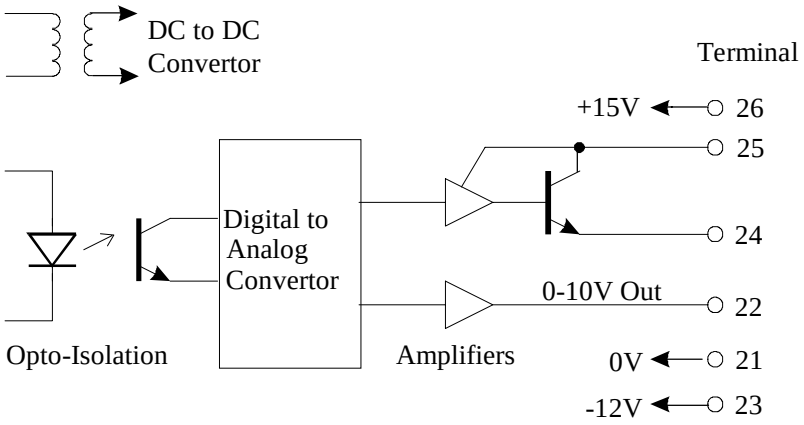
4. OPTIONS

4.1 THE 4-20mA OUTPUT OPTION

The 4-20mA output option provides an analog output of rate as either a 4-20mA current or a 0-10 Volt level. All output signals are electrically isolated from the instrument power supply and signal inputs to ensure minimum interference. The 4-20mA is directly proportional to the displayed rate.

Either 2 wire current transmission is available with the loop powered internally, or 3 wire transmission from an external loop supply.

A block diagram of the output is shown below and various methods of interconnection are outlined on the following pages.



4.1.1 Load Specification

Maximum load which the output can drive:

Internally powered loop:	500 ohms
Externally powered:	*R = (V-5)/.02*

where V is the external loop voltage
R is the maximum load in ohms.

Output impedance of 0-10 Volt source: 100 ohms

4.1.2 Calculation

Parameters relating to this option are programmed when calibrating the instrument (see section 5) and provide for:

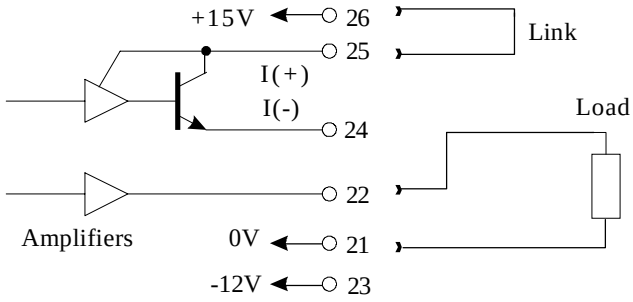
- Defining the rate which is equivalent to 4mA or 0 volts.
- Defining the rate which is equivalent to 20mA or 10 volts.
- Selecting the output range as 4-20mA (which also gives 2-10 volts on the voltage output circuit) or as 0-10 volts (which gives 0-20mA on the current output circuit).

By being independently able to set the output range, the instrument can effectively be programmed to amplify the input signal. In driving chart recorders, for example, this enables the output to zoom in on a particular operating area, instead of having to display the full operating range of the transducer.

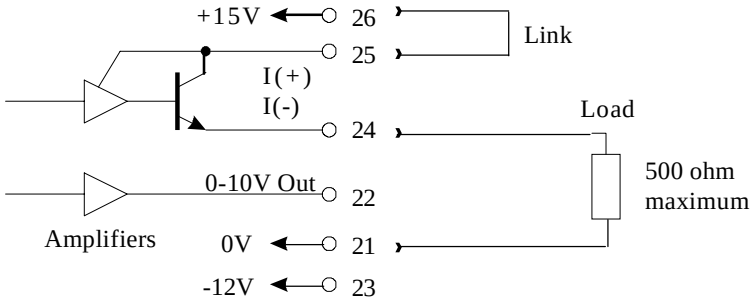
For example, 4mA may be set as 0 litres/min and 20mA as 100/litres. However, the user could set 4mA as representing 100 litres/min and 20mA as representing 120 litres/min.

For rates or displayed values above and below the maximum and minimum values the output will remain at its 20mA or 4mA level respectively.

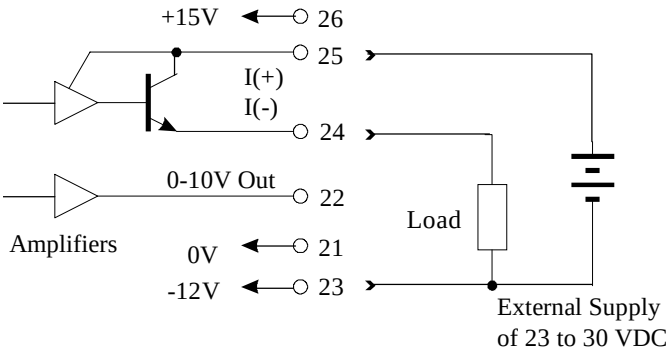
It should be noted that the output will be updated every 0.25 seconds in unison with the display and, between updates, the output value is constant .



Voltage Output Configurations



Two Wire Transmission (Internal Supply)



Three Wire Transmission (External Supply)

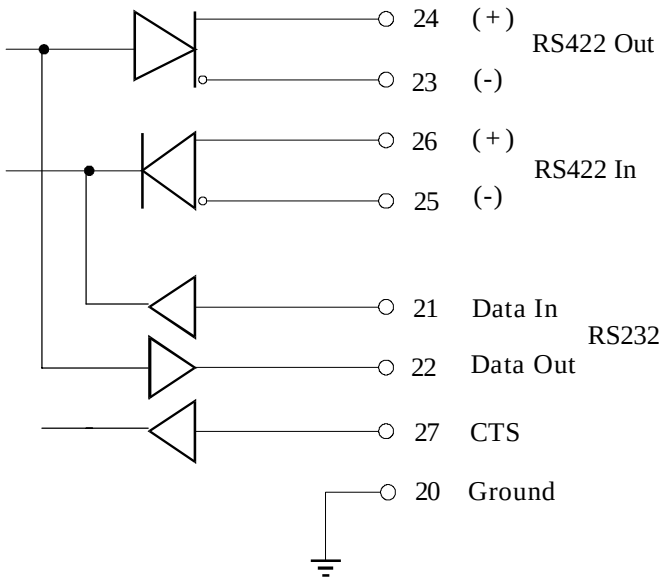
4.2 THE RS232/422/485 INTERFACE OPTION

With this option installed, the circuits for both the RS232 and RS422/485 are provided as standard. They can be used to interface to both printers and computers, and a number of standard protocols are built into the instrument.

4.2.1 Hardware

The following diagram provides an overview of the RS232/RS422/RS485 communications hardware. All three interfaces are available on the rear terminal strips and the user can select either one by making the appropriate connections.

The RS232 interface is primarily used with printers or for simple communication with a computer over a short distance. The RS422 and RS485 interfaces are used for communication over a long distance or in applications requiring multipoint communication.



4.2.2 Multipoint Communication

Multipoint Communication is a system whereby a number of instruments can be addressed over a dual twisted pair interface. Up to 32 instruments can be connected to a common bus using the RS422 and RS485 interfaces as shown below.

To convert the RS422 interface to an RS485 interface, the RS422 (-) Data In Terminal must be connected to the RS422 (-) Data Out Terminal and the RS422 (+) Data In Terminal must be connected to the RS422 (+) Data Out Terminal. These connections will convert the RS422 4 wire interface to the RS485 2 wire interface, as shown in figure 2.

Each instrument can be programmed with a unique address which is used by the Master Controller (ie IBM/PC) to identify each instrument. The Controller will send the address down the line and will alert the relevant instrument. Subsequent software protocol will control the flow of data between the Controller and the Instrument.

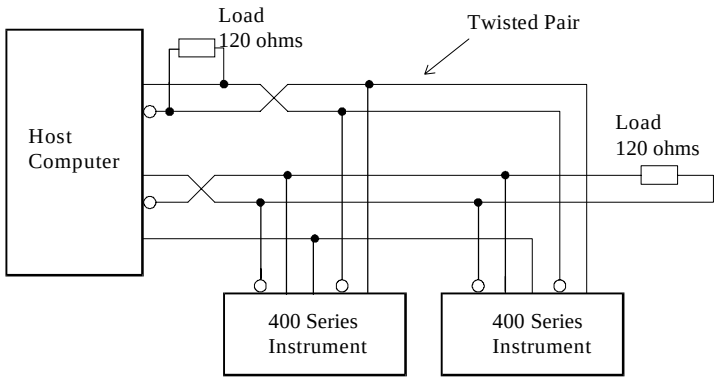


Figure 1 RS422 Interface

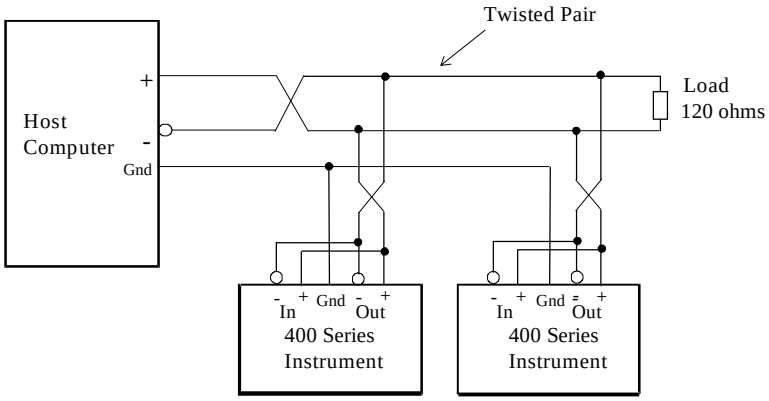


Figure 2 RS485 Interface

4.2.3 Communication Protocol

The RS232/422/485 option has a real time clock and enables the time and date to be set and printed on tickets. The date format can be European (days/months/years) or USA (months/days/years), while the time is on a 24 hour clock.

Note that the clock will only retain its time for 3 days minimum if there is no power connected to the instrument. After this period, the clock may need to be reset.

The baudrate, parity and word length can be programmed during calibration and the user must ensure that these correspond to the setting on the printer or computer with which the 405 is communicating.

The software protocols can be selected during Calibration to provide standard interfaces to a number of printers and computers. Since other interfaces will continue to be added, the user should consult the manual *"The RS232/422/485 Communications Option for the 400 Series, Version 2"*, for the latest protocols and printer drivers.

Printer

A ticket is printed each time the RESET key is pressed. The instrument prints the ticket before resetting the resettable total. Protocols are provided to drive the following printers:

1 Standard Computer Printer (Note that the printer must have an RS232 Serial Interface).
2 EPSON CTM290 Slip Printer.
3 Contrec Model 624.
4 EPSON TM290-2 Slip Printer.
5 Contrec Model 632-2.
6 Syntest SP-210.

The tickets can also be printed with a number of different units, including litres and gallons. The units are selectable from a pre-programmed list.

A CTS input is provided, and will prevent the instrument from transmitting any further characters to a printer if the printer buffer is full. The CTS input is usually connected to the "Data Buffer Full" output from the printer.

If the printer buffer is large enough to handle the message output from the instrument, then this input need not be used and should be left unconnected.

Computer

The instrument receives and transmits messages in ASCII, with all command strings to the instrument terminated by a carriage return. While replies from the instrument are terminated with a carriage return and a line feed.

Xon/Xoff protocol is also supported, and the instrument will automatically determine if the message sent by the host computer is preceded by an Xoff character. If it does recognise an Xoff as the first character of a command string, the instrument will automatically switch to Xoff/Xon protocol, and begin & end all messages with Xoff and Xon characters respectively. Xoff/Xon protocol is only available when the RS232 interface is selected.

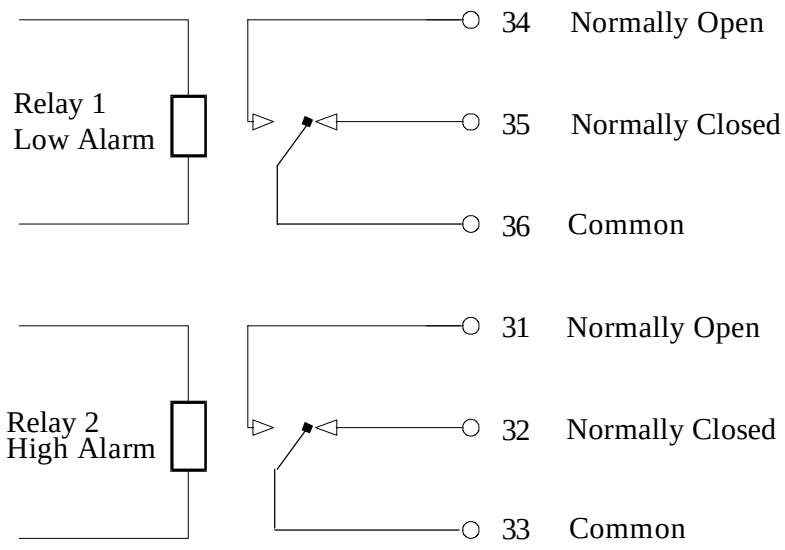
During Calibration, the instrument can be programmed to operate in a full duplex or half duplex transmission mode. In full duplex mode, all commands sent to the instrument will be echoed back to the host computer. In half duplex, the commands are not echoed.

For more information on the computer interface please consult the manual *"The RS232/422/485 Communications Option for the 400 Series, Version 2"*.

4.3 THE RELAY OUTPUT OPTION

The Relay output option consists of two Form C relays which can be preset during calibration to energise when the rate or displayed value exceeds or drops below the preset values.

The "low" relay is energised whenever the rate is below the preset value, and the "high" relay is energised whenever the rate exceeds the preset value. The preset values are programmed during calibration as described in section 5.



5. CALIBRATION

The Calibration routine enables the Setup Parameters to be programmed, as well as enabling the input signals to be checked.

The calibration routine can be entered in two ways:

1 By connecting a wire link (or switch) to the rear terminal strip across terminals 1 and 2 or,

2 By pressing the TOTAL key and, while still holding, pressing the RESET key. Both keys must then be held for approximately 6 seconds. This second method of access can be disabled during the calibration so that it is only possible to enter the calibration routine via the link across terminals 1 and 2.

The key switch actions are as follows:

RATE	will change a flashing digit, to the next digit.
TOTAL	will increment a flashing digit or change a parameter selection.
RESET	will reset a flashing digit to zero.
DISPLAY (Program)	will step through the program sequences.

Note that the arrows in the Rate and Total key switches indicate that these switches can be used to change and increment digits respectively.

In stepping through the program sequence, the Parameter Description is always displayed first, followed by the actual value or parameter. When a value or parameter can be changed, it is always shown as flashing, and the LED's in the switch panels are lit if that key switch can be used to change a value.

On first entering the Calibration routine, the display will show the Model number followed by:

CAL	Setup Program parameters.
Options	Options (if installed).
Test	Check Input Signals.
End	Exit to Normal Operation.

The user can toggle between these modes using the TOTAL switch and by using the DISPLAY switch, select the appropriate mode.

To exit Calibration, step through the Setup program or Test program until the end, and press the DISPLAY switch when **End** is displayed, (ensure the calibration link is removed).

5.1 PROGRAMMING THE SETUP PARAMETERS

Step	*Display*	*Description*	*Text Ref*
1	***CAL***	Select the Calibrate mode to setup program parameters.	
	OPTIONS	Options (if installed)	5.2
	TEST	Select the test mode to check input signals.	5.3
	END	Exit to normal operation.	
	The following steps are displayed if CAL is selected.		
2	***RESTOT***	Reset all totals to zero.	
	xxxxxx	To clear all totals (resettable total and accumulated) press the reset key.	
3	***FL INP***	Select either a single frequency input or a quadrature input (ie two pulses from a single flowmeter).	3.2
	single	Single Input.	
	quad	Quadrature Input.	
4	***CORRCT***	Select either a linear input or non-linear correction for the flowmeter input.	
	Linear	Linear Correction, or	3.5
	Nonlin	Non-Linear Correction.	
5	***SCALE***		
	If linear correction is selected, the scaling factor is programmed as follows.		
	Fact	Enter the Scaling factor (K-factor) of the flowmeter. The program then steps to step 6.	3.3

Step	*Display*	*Description*	*Text Ref*
	If <u>non-linearity correction</u> is to be programmed, up to 10 frequencies and scaling factors can be entered.		
	Freq 1	Freq1 is programmed to the first frequency point in the range of 0 to 9999Hz.	3.5
	Fact 1	This is the K-factor of the flowmeter (ie. pulses per gal, etc) at Freq1. The digits before the decimal point (whole numbers) are programmed first, followed by the decimals. The scaling factor can be programmed in the range of 0.1000 to 50,000.	
	Freq2	Freq2 is programmed to the second frequency point. If any Freq is set to 0, no further correction points can be programmed and the non-linearity correction is limited to that number of points.	
	Fact 2	Scaling Factor 2.	
	to		
	Fact 10	Scaling Factor 10. Note that Freq10 is not displayed since it must always be zero.	
6	***F dPt***	Number of decimal points with which the <u>Rate</u> is to be displayed between 0 to 0.00000.	
7	***t.base***	The <u>Timebase</u> with which the Rate is calculated must be entered as:	3.3
	60secs	units/min	
	hours	units/hour	
	days	units/day	
	secs	units/second	

Step	*Display*	*Description*	*Text Ref*
8	***FILTER***	The filter constant for filtering the rate display and the 4-20mA output.	3.3.2
	1	No filtering.	
	to		
	99	Very heavy filtering.	
9	***TOTCON***	A division factor to convert the totals to different units from those used for rate (ie gallons/min and barrels).	3.4
	1	Rate and totals have the same engineering units.	
	x.xxxx	Other factors can be programmed between 0.01 and 2000.	
10	***t.dPt***	Number of decimal points with which the resettable total is displayed between 0 to 0.000.	
11	***A.dPt***	Number of decimal points with which the Accumulated (non resettable) total is displayed between 0 to 0.000.	
12	***ACCESS***	Enable access to calibration routine via the front keyboard only.	
	Front	Enable access via front keyboard.	
	No Acc	Disable access via front keyboard.	

5.2 PROGRAMMING OPTIONS

Step	*Display*	*Description*	*Text Ref*
1	***OPTIONS***	Options (if installed).	
	Test	Check the Input Signals.	5.2
	End	Exit to normal operation.	
	CAL	Program Setup Parameters.	5.1
	If the 4-20mA output option is installed, the following will be displayed:		
2	**OUTPUT**	Select either 4-20mA or 0-10 volt.	
	4-20	4-20mA (also 2-10 volts).	4.1
	0-10	0-10 V (also 0-20mA).	
3	**OP 4**	Flowrate at 4mA or 0 volts.	
	xxxx	Enter flowrate.	
4	**OP20**	Flowrate at 20mA or 10 volts.	
	xxxx		
	If the RS232/422/485 option is installed, the following will be displayed:		
5	**DF**	Date Format.	
	Eur	European (ie. days/months/years).	4.2
	USA	USA (ie. months/days/years).	
6	**Date**	Enter date as:	
	xx:xx:xx	Years:Months:Days.	
7	**HOUR**	Enter time as a 24 hour clock.	
	xx:xx	Hours:Minutes.	

Step	*Display*		*Description*	*Text Ref*
8	**BAUD**		Baudrate	
	xxx		300, 600, 1200, 2400, 4800 and 9600 .	
9	**DATA**		Word length.	
	7		7 bits.	4.2
	8		8 bits.	
10	**PARITY**		Parity.	
	NP		No Parity.	
	OP		Odd Parity.	
	EP		Even Parity.	
11	**SIGNAL**		Signal Type.	
	rs232		RS232.	
	rs422		RS422/RS485.	
12	**ID NO**		Unit Identification Number.	
	0		None.	
	1-99		Id Number.	
13	**PTYPE**	**xx**	Printer/Computer Type.	
		00	Standard Computer Printer.	
		01	EPSON CTM 290 Slip Printer.	
		02	Contrec Model 624 Printer.	
		03	EPSON TM290-2 Slip Printer.	
		04	Contrec Model 632-2 Printer.	
		05	Syntest SP-210 Printer.	
		20	Computer.	

Step	*Display*		*Description*	*Text Ref*
	If a Printer Protocol is selected, the following message is displayed:			
13	**UNIT**	**xx**	Units of measurement printed.	
		00	None.	
		01	Litres (Ltrs).	
		02	Gallons (Gals).	
		03	Barrels (bbls).	
		04	Pounds (lbs).	
		05	Grams (gms).	
		06	Kilograms (kgs).	
		07	Tons (tons).	
	If a Computer Protocol is selected, the following message is displayed:			
13	**ECHO**		ECHO Command.	
	On		Echo (Full Duplex).	
	Off		No Echo (Half Duplex).	
	If the Relay Option is installed, the following will be displayed:			
14	**AL: Hi** **xxxxxx**		High Alarm switching point. The high relay will energise if the flowrate exceeds this value.	4.3
15	**AL: Lo** **xxxxxx**		Low Alarm switching point. The low relay will energise if the flowrate falls below this value.	

5.3 CHECKING THE INPUT SIGNAL

Step	*Display*	*Description*	*Text Ref*
1	***TEST***	Check the Input Signals.	
	OPTIONS	Options (if installed).	5.2
	CAL	Program Setup Parameters.	5.1
	END	Exit to normal operation.	
	The following steps are displayed if ***TEST*** is selected.		
2	***Sr x.xx***	Software revision number.	
3	***Freq***	Displayed for 1 second followed by the actual frequency.	
	xxxx.x	Frequency in Hz. If a quadrature input is selected and the flow is reversing, a negative sign will appear.	
	If the RS232/422/485 option is installed, the display will then show:		
4	**CLOC**	Clock.	
	xx:xx:xx	Time in Hours:Mins:Sec.	

6. INPUT CIRCUITS

6.1 FLOW INPUTS

The Model 405Q has two pulse input circuits:

- Channel 1 is used with both single and quadrature input signals. The Channel can interface directly to
  - Turbine Flowmeters
  - Open Collector Outputs
  - Reed Switches
  - Logic Signals
  - Namur Sensors

- Channel 2 is used only when a quadrature input is selected, and becomes the 0° input while channel 1 becomes the 90° input. Channel 2 can interface directly to
  - an Open Collector
  - a Reed Switch
  - a Logic Signal
  - a Namur Sensor

The frequency input circuits for the Model 405Q can be configured by the user to interface with most flowmeters. A small 8 pole DIL switch on the rear of the instrument is used to set up the input circuit to operate with different types of signals.

The input circuit is shown on page 40 and examples of flowmeter interconnections are given on pages 41 and 42.

Switch Settings

The following are recommended switch settings for different input signal types.

Note, input types d and e are only available on Channel 1. Channel 2 is limited to signal types a to c.

Input Signal Type	Input Terminals				Switch Settings							
	CH1		CH2									
	+	-	+	-	1	2	3	4	5	6	7	8
a. Logic Signal, CMOS, Pulse	9	8	3	8	off	off	off	off	on	off	off	off
b. Open Collector or Reed switch	9	8	3	8	off	off	off	off	on	off	on	off
c. Namur Proximity (set DC out to 8 volts)	11	9	11	3	on	off	on	on	on	on	off	off
Channel 1 Only												
d. Switch or Reed Switch with debounce circuit (200Hz max)	9	8			off	off	off	off	on	off	on	on
e. Coil (20mV P-P minimum)	9	8			off	on	off	off	off	off	off	off

General Specification

Switching Threshold: 2.5 Volts (except for input type c and e)

Maximum Input Voltage: 50V peak

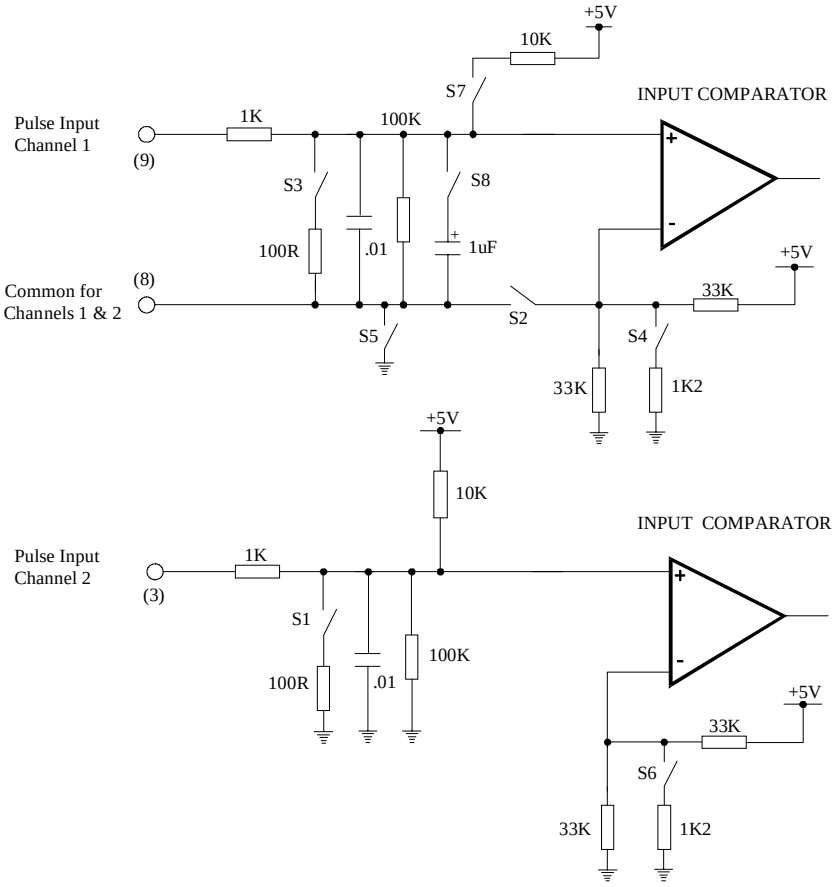
Input Impedance

- Input type a: 100K on channel 1, 10K on channel 2
- Input types b & d: 10K
- Input type c: 1K
- Input type e: 100K

Powering of Sensors

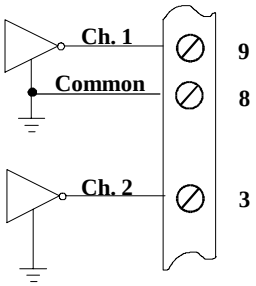
The Model 405Q has a regulated DC output which can be used to power sensors. A trimpot on the rear of the instrument allows the voltage to be adjusted in the range of 8-24 Volts and the output can supply a maximum of 50mA.

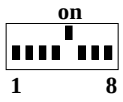
Note that when using this DC output to power opto-sensors, some flowmeter manufacturers require that a current limiting resistor be used. Please refer to the flowmeter manufacturers data sheet if this is the case.



The Frequency Input Circuits

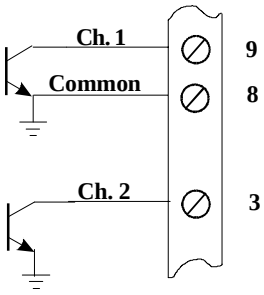
1. Squarewave, CMOS or Pulse

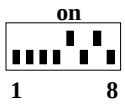




eg. vortex, pre-amplifiers
or magnetic flowmeters

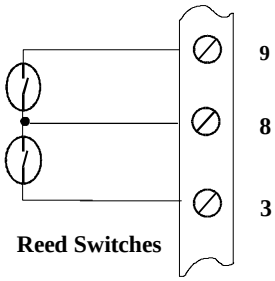
2. Open-Collector

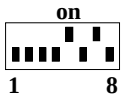




eg. preamplifiers
and opto-sensors

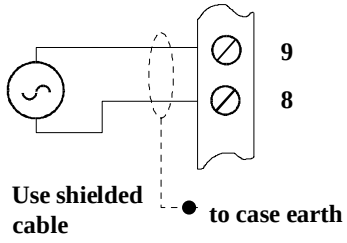
3. Reed Switch

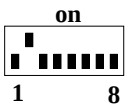




eg. positive displacement
flowmeters with reed switch
outputs.

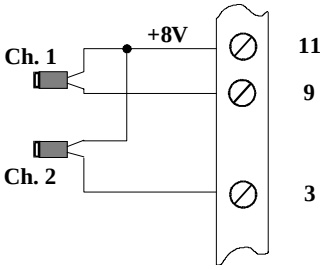
4. Coils

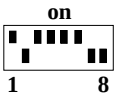




eg. millivolt signal
from a turbine flowmeter
(single input only)

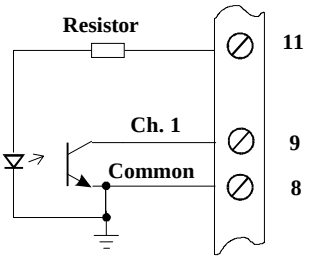
5. Namur Proximity Switch

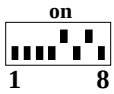




eg. positive displacement
flowmeters with 2 wire
proximity switch outputs

6. Opto-Sensors





eg. pre-amplifiers
and opto-sensors.

Note that the current
limiting resistor may be
required. See the flowmeter
manufacturer's data.

7. INSTALLATION

7.1 GENERAL

Terminal designations for the Model 405Q Flow Computer are given on the following pages. The cutout hole in the panel should be 5.5" (139mm) wide x 2.6" (67mm) high. Two side clips are supplied to secure the instrument into the panel.

A case earthing point is provided via an earth lug on the side of the case. Note that this earthing point is for the case only and there is complete electrical isolation between this point and all electronic circuits. For EMC purposes, or when the instrument is connected to mains, this point must be connected to a good earth using a multi-stranded, braided wire or strap. All relay outputs are totally isolated from the case and from the internal circuitry.

A Supply Output voltage is provided to power sensors. This output will provide a regulated voltage of 8 to 24 volts and the voltage is adjustable by means of the potentiometer on the rear panel. Maximum current is 50mA and the instrument comes with the voltage factory set at 24 Volts. When the instrument is powered from a DC power source, the maximum output voltage on the Supply Output is the DC Input Voltage less 3.5 volts.

The instrument will operate from either 12 - 28 volts DC or from the mains. The mains voltage is factory set to either 95 - 135 VAC (110 VAC nominal) or 190 - 260 VAC (220 VAC nominal). An internal mains transformer provides full isolation between the mains and the electronic circuits.

The DC Ground terminal 12 provides a common ground for the 12 - 28 Volt power input, the 8 - 24 Volt output and the pulse output.

It is good practice to use shielded cables for all signal connections to the Model 405. Care must be taken to separate signal cables from power cables so as to minimise interference.

Overall shields should be connected to the case earth at the instrument end only. This connection should be as short as possible and connected to the earthing lug on the side of the case.

In order to comply with the requirements for Electromagnetic Compatibility as per EMC-Directive 89/336/EEC of the Council of European Community, this wiring practice is mandatory.

Although it is also possible to connect shields to the signal ground (terminal 2) this practice is not in accordance with EMC directives.

RC Networks for Interference Suppression

When driving highly inductive loads with the relay outputs, it is recommended that RC suppression networks (often called "Snubbers") are used for two 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 dependant entirely on the load. However, if the user is unsure of the type of snubber to use, values of 0.25uF and 100 ohms will usually suffice. Note that only mains approved RC suppression networks should be used.

The basic principle of operation is that the capacitor prevent 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.

7.2 WIRING DESIGNATIONS FOR THE MODEL 405Q

Terminal	*Model 405Q*
1	Calibration Link
2	Signal Ground
3	Flow Pulse Input (Channel 2)
4	Not To Be Used
5	Not To Be Used
6	Not To Be Used
7	Flow Alarm
8	Flow Common (-)
9	Flow Pulse Input (Channel 1)
10	Pulse Out
11	DC Power Out (8-24 VDC)
12	DC Ground
13	DC Power Input
14	Not To Be Used

Terminal	*Analog Flow Output*	*RS232/422/485*
20	Not To Be Used	RS232 Signal Ground
21	0 Volts	RS232 Data in
22	0-10 Volts	RS232 Data Out
23	-12 Volts	RS232 (-) Data Out
24	I(-)	RS422/485 (+) Data Out
25	I(+)	RS422/485 (-) Data In
26	+15 Volts	RS422/485 (+) Data In
27	Not To Be Used	RS232 CTS

Terminal	*Relay Option*
31	Relay 2 - Normally Open
32	Relay 2 - Normally Closed
33	Relay 2 - Common
34	Relay 1 - Normally Open
35	Relay 1 - Normally Closed
36	Relay 1 - Common

8. TROUBLE SHOOTING

8.1 ERROR CODES

The instrument has extensive self test facilities and will display an error code if it detects an invalid condition. If the instrument displays an error code other than those listed below, please contact the factory.

Error codes are displayed as "Err 12" and a list of commonly encountered codes are given below:

Error Codes

Input Errors

11 Invalid input configuration programmed.
13 Quadrature error detected. That is, an unequal amount of pulses detected on the inputs (see section 3.2).
14 Communications Input error (RS232/422/485 Interface).

Output Errors

21 Invalid output configuration.
22 Communications error - Baud rate not set.
23 Communications error - Printer fault.

Calibration Errors

30 Zero Value not allowed.
33 Invalid Printer Type.
34 Invalid Volume Units selected.

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