FCO732
FLOW METER

USERS GUIDE

Please read carefully before using.

Manufactured by:

FURNESS CONTROLS LIMITED

Beeching Road, Bexhill, East Sussex, TN39 3LG, England.
Telephone +44 (0)1424 819980
Email: sales@furness-controls.com
Web Site: http://www.furness-controls.com/

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REVISION RECORD

Issue	Date	Summary of changes
13	17/11/2020	Updated for firmware x732A11, x732B12. New function data option End On Gross for flow tests.
12	05/02/2020	Updated for firmware x732A10, x732B11. Pressure and flow display resolution options.
11a	28/08/2019	Simplified LAN baud rate and parity descriptions.
11	07/06/2018	Dimension drawings updated
10a	20/10/2017	Minor correction to connection diagrams
10	20/07/2017	Updated for firmware x732A09, x732B10. Replaced RS232 Format menu with Printer Settings and Fbus Settings. Added FCO732 ID to commissioning menu and printer settings. Optional LAN for enhanced firmware. Installation drawings amended for new stock material size for 2,6,10 and 20L, and 30L LFE's.
9	19/12/2016	Updated for firmware x732A08, x732B09 Added 'Pass' to programmable outputs.
8a	01/09/2016	Cal Learn lower limit corrected to state 2.5% instead of 10% Pressure zero limit corrected to state 7.5% instead of 14%
8	18/08/2016	Updated for firmware x732A07, x732B08 Add print to ZPL II Form, print sequence result and print step ID. Product selection by BCD inputs is selected from Alter Product in program data instead of a function data option. New utilities to check printer and fbus communications.

SAFETY NOTES AND RECOMMENDATIONS

PLEASE READ CAREFULLY

1. Read these instructions and this guide carefully.

2. This equipment requires a 24V DC power supply that must be appropriately fused.

3. Always unplug the equipment from the power supply before servicing.

4. Do not use the equipment near water. In the event of a spillage onto the instrument remove the power supply to minimise the risk of damage.

5. The air supply should be connected via an emergency shut off valve located close to the instrument.

6. If an internal pressure control is fitted it must not be used with hazardous gas because it vents inside the instrument.

7. The air supply must not exceed that specified on the instrument or in the Test Certificate.

8. **Filters must be fitted to the air supply to remove oil and water that can damage pneumatic components. The filters should be periodically checked and drained as necessary. Failure to do so may invalidate the guarantee.**

9. Nylon air supply pipes must be kept away from hot areas as this can weaken the pipe.

10. Ensure that blanking plugs are pushed in fully before applying air.

11. The air supply must be turned off before carrying out any work on the pneumatic system.

12. If in doubt about any aspect of safety with the equipment then contact Furness Controls BEFORE proceeding.

INTRODUCTION

General Description

The FCO732 flow meter is suitable for production line testing of gas industry appliances and valves, calibration of fuel injectors and many other flow measuring applications. Advanced microprocessor based electronics make this instrument simple to use from the front panel, as well as being easily interfaced to other equipment such as PLC's or PC's where automatic operation is required.

The FCO732 can read true volume flow rate, with automatic compensation for static pressure, gas temperature and gas type. The FCO732 also has a Calibration Check function that allows comparison against a master test piece – this is useful when variables such as gas viscosity are unpredictable, e.g. natural gas may vary during the day.

Test pressure and flow rate can be displayed with a choice of imperial or SI units, and compared to programmable limits to give a pass or fail result clearly displayed on the front panel and output to the rear connectors. Test results can also be printed or logged by a computer.

The standard FCO732 (x732A) is a basic function single test instrument with minimal inputs and outputs, sufficient to implement a simple remote box with lamps, or basic control from a PLC.

An enhanced firmware version (x732B) is optionally available that can test up to fifty different products, components or sub-assemblies. Alternatively, a simple sequence of up to eight tests may be performed. With the enhanced version, the input/output capability can also be optionally enhanced for jig / PLC interfacing, e.g. BCD inputs for product selection and programmable outputs for BCD verification or jig control.

Throughout this guide, the enhanced version features are shown in this colour.

Housing

The standard FCO732 is housed in a freestanding bench-top case having two extending front feet that allow the case to be tilted so that the front panel can be seen more easily. The FCO732 is optionally available with a half 19" x 3U rack housing.

Front Panel

The front control panel houses the main display, status lamps, five function buttons, and the start and reset buttons. A front panel pressure control is optional.

Display Result lamps Start and reset buttons

Optional pressure control Navigation buttons USB-B port
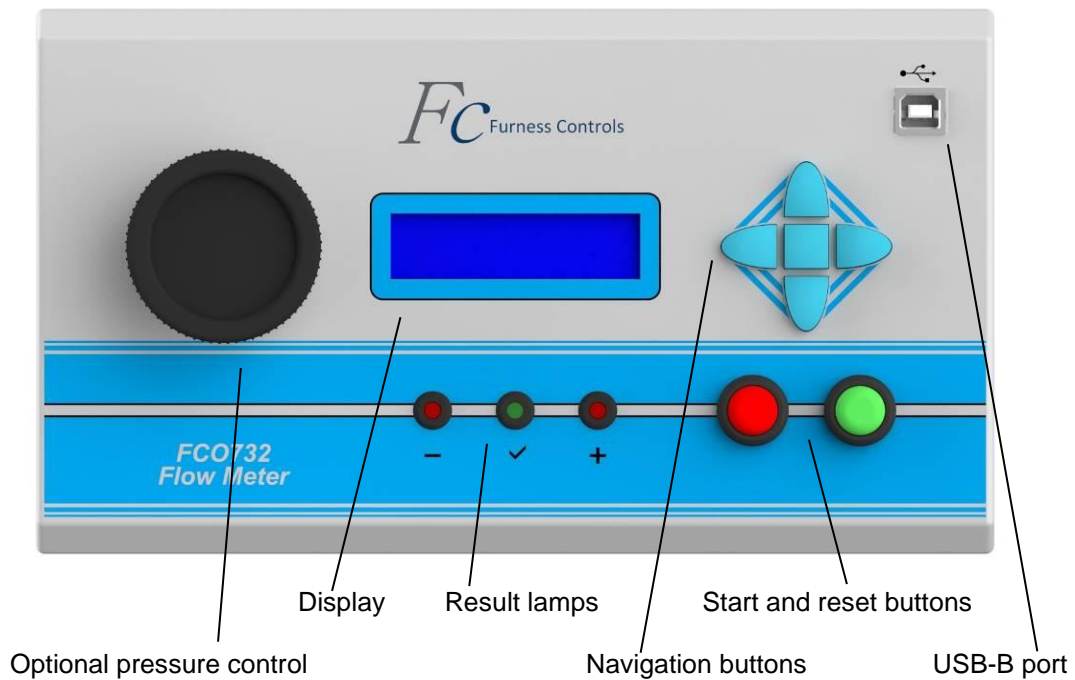
Display

The Liquid Crystal Display has 2 lines of 16 characters and is illuminated for clear indication. This display is used to show data when programming the instrument, and operational status and result values when testing.

Result Lamps

Three lamps on the front panel show the result of each test:

 The red HIGH lamp indicates that the flow being measured is above the higher limit setting.

 The green PASS lamp indicates that flow being measured is between the lower and upper limit settings.

 The red LOW lamp indicates that the flow being measured is below the lower limit setting. Setting the low level to zero will disable the LOW lamp; this is useful for performing GO/NO-GO tests.

Note: The lamps may be configured to work from either the flow or pressure limits.

If the lamps are indicating the condition of flow and the pressure is above or below its set limits then both red lamps are lit, the fault output is activated, and a fault message is displayed.

If the lamps are indicating the condition of pressure and the flow is above or below its set limits then both red lamps are lit, the fault output is activated, and a fault message is displayed.

Push buttons

'START'   The green button will start the test provided the remote control option has been set to N. See the functions menu for details.

'RESET'	The red button will reset the instrument if a test cycle is running.
UP & DOWN	These are used move through the menu lists, and to alter numeric data or menu options.
ENTER	The centre button is used to select menu options and enter data into memory.
LEFT / BACK	This is used to return back to a menu heading and move the cursor left when setting data.
RIGHT	This is used to move the cursor right when setting data.

Off Button

The FCO732 may be turned off using the **BACK** button when the instrument is in its normal standby state. Press and hold the **BACK** button: there is a 1½ second delay to avoid accidentally switching the instrument off, during which time a progress bar is displayed. Press the **BACK** button again to power up. This feature is not available on older instruments that have had firmware upgrades, and may be disabled via the security menu.

Pressure Control (optional)

This is a manual control for adjusting the internal pressure regulator, which sets the test pressure. It is normally adjusted in the set-up procedure, when the pressure is displayed in a continuous mode.

The internal pressure control must not be used with hazardous gas as it vents internally.

For gas use, a suitable gas governor may be used in the external supply circuit.

USB-B Port

The front panel USB-B port is a dedicated Fbus communications port (with Fbus ID 01) that may be used to connect a PC for instrument configuration etc. Note that a device driver for the USB port may need to be installed on the PC; this is available on the product CD supplied with each instrument. Older instruments do not have this port.

Rear Panel

The rear panel houses the electrical connections and main pneumatic connections.

AIR SUPPLY
MIN. 5B/MAX. 10B

REGULATOR
SUPPLY

TEMP.
SENSOR

PRESSURE +

0V

-24V

24V ⎓12VA

INPUTS

INTERNALLY LINKED

12
10
8
6
4
2
COM
-24V

COM
11
9
7
5
3
1
0V

INTERNALLY LINKED

RS232

P1

P2

REGULATED
AIR OUT

FLOW

Optional additional
communications

-24V
+
2
4
6
8
10
12
14
16

0V
0V
1
3
5
7
9
11
13
15

OUTPUTS

ISOLATED
RS485

ANALOGUE
OUTPUT

Furness Controls
Bexhill, England
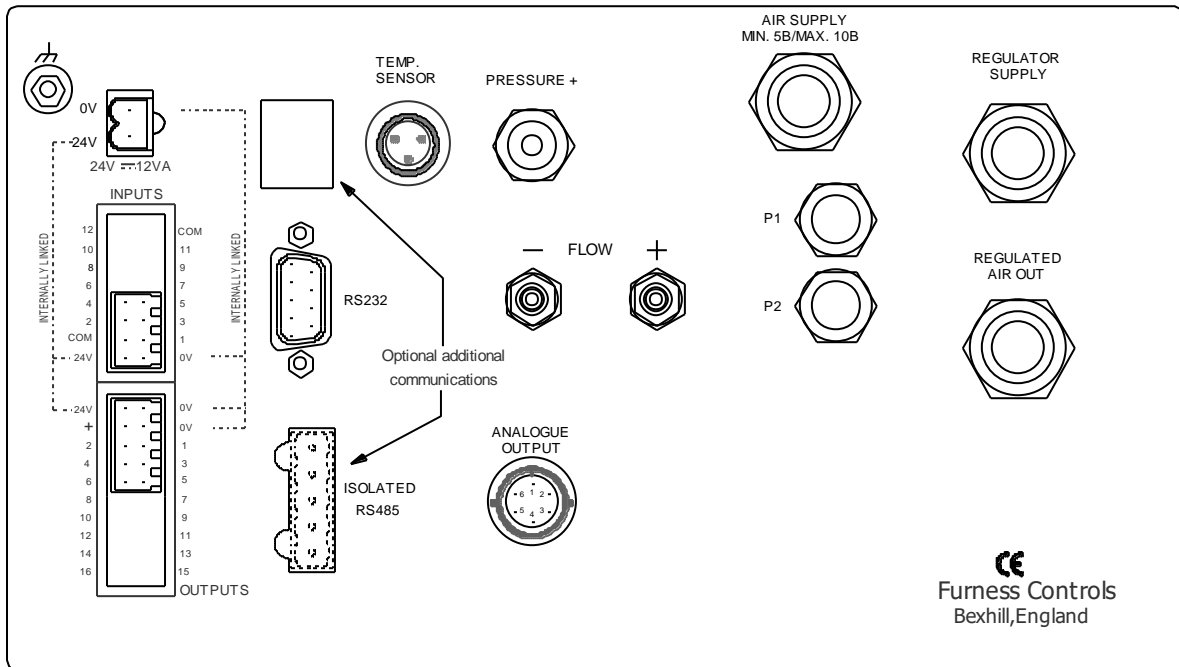
Electrical Connections

For individual pin functions, see the "input/output connectors" section of this guide.

24V Power Connector

The external 24V DC supply connects via this 2-way detachable screw-terminal. The instrument is protected against reverse polarity and has an internal auto-resetting fuse. The Furness Controls 24V supply is grounded. If a different supply is used it must be grounded – the ground stud can be used for this purpose.

Temperature Sensor

When temperature compensation is used a sensor mounted in the Laminar Flow Element plugs in here.

Input Terminals

This is a detachable tension clamp terminal block requiring a small screwdriver to insert and remove wires. The start and reset inputs are user-configurable for active high or active low operation. When the enhanced firmware option is used there is also an option for additional inputs that may be used to provide BCD selection of product.

Output Terminals

This is a detachable tension clamp terminal block requiring a small screwdriver to insert and remove wires. There are six active high outputs for results and status. The enhanced firmware version optionally has eight programmable outputs for use as step or BCD output.

RS232 Plug

The 9-way RS232 plug can be used for print-out or to allow the instrument to be set-up, controlled, and results to be collected from a remote computer or PLC.

RS485 Port (optional)

The 5-way detachable screw terminal (9-way D socket on older models) RS485 port allows the instrument to be set-up and controlled and for results to be collected from a remote computer or PLC. RS485 is a multi-drop interface allowing a number of instruments to share the same communications link. This is unavailable for use if the LAN is selected.

LAN (optional, enhanced version only)

The LAN (Local Area Network) interface allows the instrument to be set-up and controlled and for results to be collected from a remote computer or PLC. This is unavailable for use when the RS485 interface is selected. The use of the LAN interface requires detailed network knowledge and is documented separately from this guide. The instrument's IP address may be set via the commissioning menu.

Analogue Output Socket (optional)

A 0-5V or 0-10V DC signal is available for the flow signal.

Pneumatic Connectors

"Flow +", "Flow -" Ports

These ports connect to the differential pressure taps of the Laminar Flow Element.

Regulator Supply

This port supplies the internal pressure regulator where fitted.

Regulated Air Out

When an internal regulator is used, this is the output.

Pressure + Sense Port

The port is used to measure the pressure at the inlet to the test item.

Pneumatic Pilots P1 and P2 (optional)

Two pneumatic pilot outputs P1 and P2 are optionally available. These default to the Jig and Bypass functions respectively but may be programmed for alternative functions if required. See the Function Data menu.

Air Supply (optional)

This is used for the optional pneumatic outputs.

INSTALLATION

Unpacking

Unpack the instrument carefully. If there is any transit damage, please report it immediately. Check that all the necessary fittings are present as shown on the packing sheet.

General Considerations

Before the FCO732 can be installed, the test arrangement must be decided. Consideration must be given to the following:

- Install the flow element before or after the test item?
- Mounting of the Laminar Flow Element.
- Use the FCO732 regulator or an external pressure controller?
- Is it necessary to measure the pressure directly at the entry to the test item?
- Is a cut off valve required to prevent gas wastage when not testing?
- Display standard or actual flow?
- Is the test system required to measure varying flow or varying backpressure?

Flow element location.

The flow element can be configured to measure the flow going into the test item or it can be configured to measure the flow coming out of the test item. Both scenarios have advantages and disadvantages.

Flow element mounted before test item:
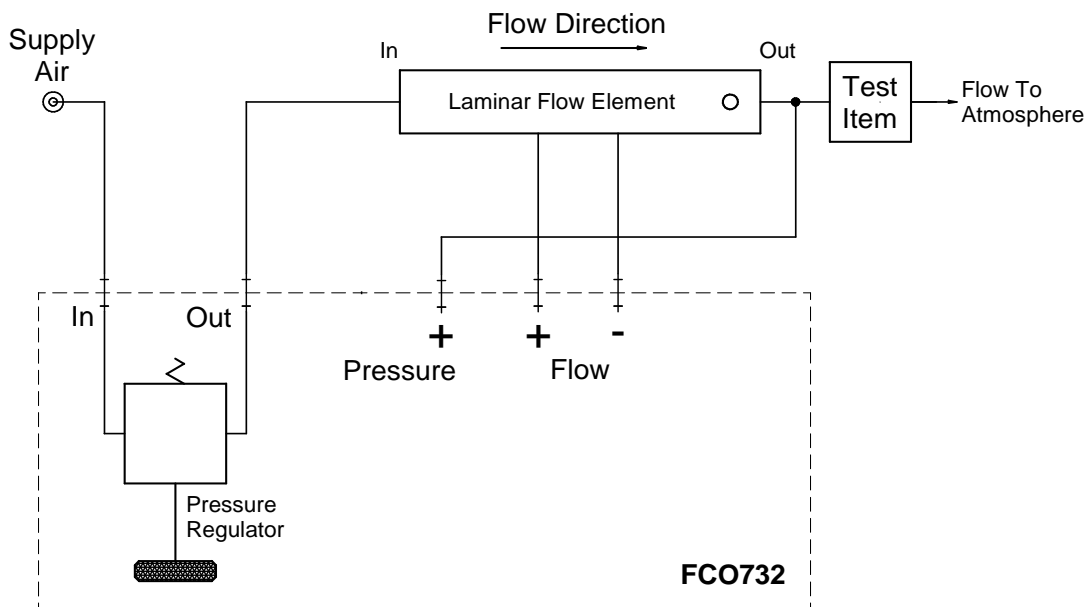
The Orifice Pressure option in the Program Data menu should be set to "EXT." so that the flow reading is corrected for the pressure of the test item, measured by the sense port.

Advantages:
- This method can be used if it is not possible to connect to the outlet of the test item.
- Only one connection to the test item is required.

Limitations:

- The pressure in the flow element must not exceed 4bar.
- The flow element can be affected by fluctuations from the pressure regulator.
- The pressure in the flow element must be re-stabilised for every test.
- The pressure in the flow element affects the measurement range and resolution when displaying standard flow.
    - The FCO732 measures flow by reading the differential pressure generated by the laminar flow element. It uses all of its d.p. sensor range to measure its nominal rated flow at standard pressure.
    - The d.p. varies by the standard pressure divided by the absolute pressure in the flow element. This is taken into account when displaying standard flow.
    - At lower pressures in the flow element, more d.p. is generated for the same standard flow meaning that the instrument's flow range must be derated when testing with a partial vacuum, e.g. a 200l/m instrument will only be able to measure 100l/m at a test pressure 500mb vacuum because the d.p. will overrange.
    - At higher pressures in the flow element, less d.p. is generated for the same standard flow leading to lower measurement resolution, although this is rarely an issue.

Flow element after test item:
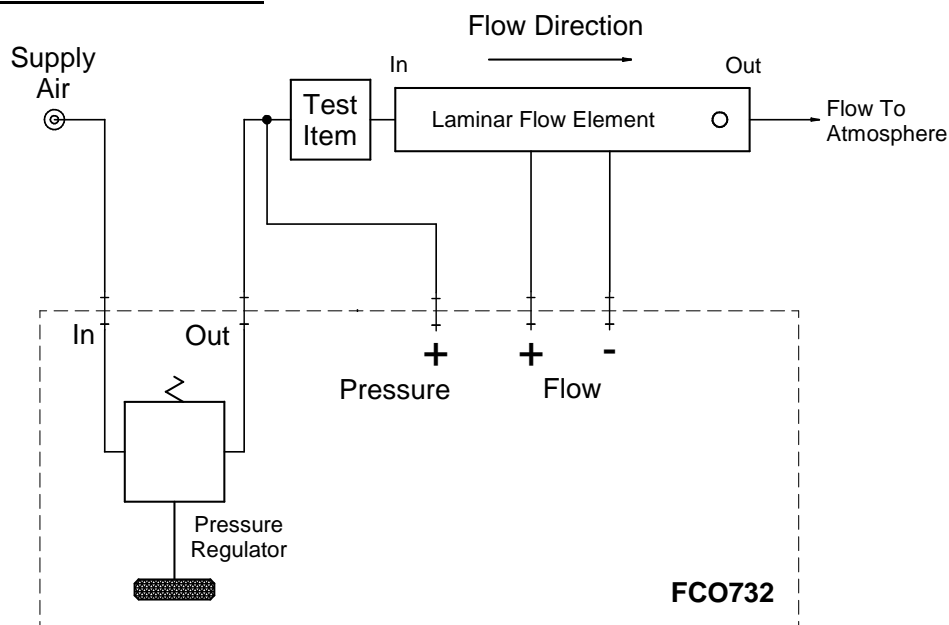
With this configuration the Orifice Pressure option in the Program Data menu should be set to "ATM." as no corrections for the orifice pressure are required.

Advantages:

- Fluctuations in the test pressure from the pressure regulator do not affect the flow elements readings.
- The flow element is always at atmospheric pressure so stabilisation times are shorter.
- The test pressure to the test item can be in excess of 4bar.

Limitations:

- It must be possible to connect to the outlet of the test item.

Mounting of the flow element

The flow element is mounted away from the instrument. There are two pneumatic connections of 4mm OD 3mm ID tubing and an electrical cable for the temperature sensor.
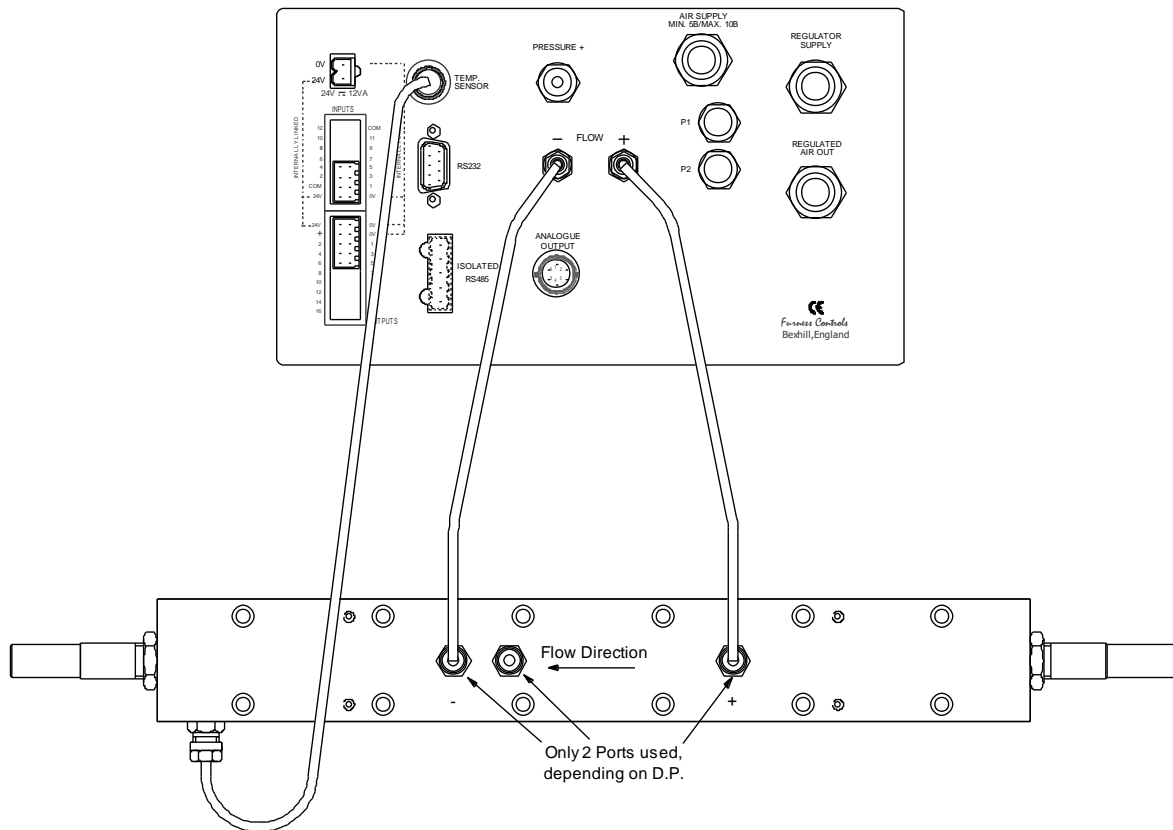
The flow entry to the flow element should be straight for at least ten diameters upstream and six diameters downstream before any bends or elbows are fitted. This will provide the best accuracy from the installation.

For operation with gases other than air it is important that the orifice is mounted at the same height as the main instrument with no loops in the inter-connecting pipes. This is to avoid gasses of different density from collecting in the pipes and causing auto zero errors. If this is not possible Furness Controls should be contacted to discuss the possibilities of fitting a purge system to the instrument.

Internal/external pressure control

If the test is to use air up to a maximum flow rate of up to 100l/m then the instrument's internal pressure regulator can be used to control the test pressure. Pipes and fittings between the pressure controller and the test item should be kept as short and as large bore as possible to prevent significant pressure loss down the pipes.

 For greater flow rates or for hazardous gasses, an external regulator must be used.

The internal pressure control must not be used with hazardous gas as it vents internally.

Pressure measuring point

The pressure measuring sense port should be connected as close as possible to the test item to obtain the most accurate results.

Cut-off valve

A cut-off valve is required if it is possible to have gas flowing through the open test connector when the test item is not fitted, or if the flow will exceed the instrument range if the test item is removed. The use of a cut-off valve can also speed up the testing of small items. The valve can be controlled by the 'JIG' output available on the Status Outputs plug at the rear of the unit (see Input/Output Connectors section). Alternatively, when enhanced firmware is used there is a purchase option for two pneumatic pilots: P1 is the Jig Output that may be used to control a cut-off valve.

LFE bypass valve

For some applications it is necessary to fill a test item faster than the restriction of the laminar flow element allows. There is a purchase option for two pneumatic outputs: P2 defaults to the Bypass Output which may be used to control a valve to bypass the LFE – note that the LFE is normally bypassed and the output is active to stop the bypass. The Product Data menu has a Fill Timer for use with a bypass valve.

Display standard or actual flow

The FCO732 normally displays flow at standard conditions, i.e. 1013mb and 20°C. The standard temperature may be changed, e.g. to 15°C, in the Program Data menu if required.

In order to display the flow at working conditions it is necessary to disable the pressure and temperature corrections: in the Program Data menu, set 'Orifice Pressure' to ATM; in the Functions menu, set 'T. Compensation' to NO.

Flow or pressure measurement

The FCO732 can be configured to work with the pass/fail lamps on pressure. This allows the instrument to measure varying back-pressure with a constant flow. The normal method of setting a constant flow is to use a regulated high-pressure source and a fine restrictor valve.

Location

The flow meter should be located close to the test item to keep the test pipes as short as possible. The test system should be installed away from any sources of temperature change; e.g. heaters and draughts. Avoid positioning the instrument near to high power machines such as welders. The instrument site should be free from vibration.

The flow meter, flow element, pipe work and test piece should all be at the same height to avoid errors due to varying gas densities.

Electrical Supply

Connect a suitably fused 24V DC supply to the instrument. The instrument must be connected in compliance with all local electrical regulations.

Electrical Control

To ease commissioning the instrument can be run from the front panel buttons. See the Remote Control option in the Functions menu. Once the instrument is operating satisfactorily, it may then be connected to a different controller if required.

Electrical Outputs

The outputs are active high transistors (i.e. switching the positive supply). The current per output must not exceed 120mA. If it is necessary to have mains operated lamps or any other high voltage or heavy current device, the outputs should be used to drive external relays.

Wiring Considerations

Electrical Interference

Ignition transformers, arc welders, mechanical contact relays and solenoids are all common sources of electrical noise in an industrial environment and therefore the following guidelines must be followed:

Noise generating devices such as those listed should be mounted in a separate enclosure. If this is not possible, separate them from the instrument by the largest distance possible.

Provide separate cable runs for communication lines, inputs and outputs. If they run parallel, there should be as much separation between the groups as possible.

RS232 and RS485 connections must use shielded cable. This will reduce the level of electrical noise induction on the wires. Lead lengths should be kept to a minimum. The shield should be grounded at one end only.

Inductive loads

When inductive loads such as relays or solenoids are switched off, they can produce a very large negative voltage spike. If the cable feeding the inductive load is bundled with other cables, the spike can be induced into the other cable and can cause unpredictable results. It is therefore important that any inductive load is suppressed at source to prevent interference.

The transistor outputs from the FCO732 clamp the peak voltage of the spike, primarily to protect the outputs, but additional suppression at the load is preferred. If an inductive load is being activated from a PLC or another relay, then suppression should be used. Suppression is usually achieved by fitting a 'flyback' diode in parallel with the load as shown.
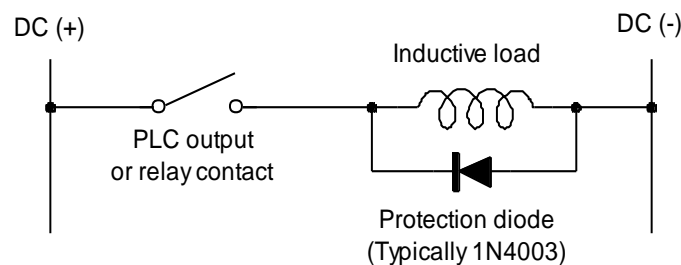
Pneumatics

Note: Supply air should be dry and clean. External filters MUST be fitted to provide full protection. Contamination by oil and water from the air supply will damage the instrument and invalidate the guarantee. Drain off any water from an air line tapping point before connecting the instrument. Disconnect the instrument during periods of factory shutdown and drain the air line before reconnection.

Instruments fitted with internal air pressure regulators are not suitable for use with gases other than air! The regulators normally fitted are of the venting type.

Instruments for use on inflammable gases are not fitted with internal regulators.

An external pressure regulator can be used, providing that it meets with the pressure and flow requirements of the test item.

Connect the pneumatics as required for the test procedure. Refer to the beginning of this chapter for connection methods.

Note: The knurled pneumatic fittings should only be finger tight. The hexagonal faces on the fittings are to aid removal and not for tightening up the fitting. It is IMPORTANT that the correct size tube is used to ensure that there are no leaks. The tubing must also be able to withstand the maximum pressure.

It is recommended that a leak test be carried out on the whole system before use, especially if inflammable gas is being used (refer to the commissioning section).

COMMISSIONING

Use the Menu Navigation Diagram as a guide to the location and layout of the setting up menus.

When commissioning an automatic control system, it is recommended that the instrument is initially checked using the front panel controls if possible.

Switch On

Apply power; the instrument briefly displays the firmware version number, e.g. X732A01, while it performs a self-check. See the ERROR MESSAGES section any error messages are displayed. If all is well the display will show "READY".

Leak Checking the Test System

The instrument will only give valid test results if the complete test system is free of any leak. To establish the integrity of the system the following method should be used.

Set the following data. Only relevant options are listed. All other options will not affect the checks for leaks.

Program Data

FLOW	LEVELS
PRESSURE	LEVELS
READ	CONTINUOUS
ALTER PRODUCT	FRONT PANEL

Product Data

TEST TYPE	FLOW	
PR. LOW	0000	set to minimum
PR. HIGH	?????	set to maximum
FL.LOW	00000	set to minimum
FL.HIGH	?????	set to maximum
STAB.	0.0 SEC	
DELAY	0.2 SEC	
REL. VISCOS	1.00	

Auto Zero

A.Z AT START	Y

Functions

REMOTE CONTROL	NO
PR. CORRECTION	NO

Either blank off the fitting that the test item is to be attached to, or fit a test item and blank the output of the test item.

Press the start button, the instrument should auto zero then the flow and pressure readings will be displayed. Use the instrument's pressure regulator, if fitted, or an external pressure control to adjust the pressure to read the highest pressure that it is required to test at. A leak tight installation will show zero flow reading.

Setting the Test Pressure

It is IMPORTANT to set the pressure under flow conditions to compensate for pressure losses in the pipe work between the pressure regulator and the test item.

You should ensure that the pressure zero is correct. This can be set from the Commissioning menu.

Connect a good test item to the system and press the start button. When the pressure and flow readings settle down adjust the pressure regulator to give the required pressure.

Measure the pressure under these flow conditions and set the pressure level to this value. Adjust the pressure limits to the required level. This is best done by measuring the pressure on test items giving the highest and lowest acceptable flows observed over a spread of test items.

Continuous reading verses single reading

There are two methods of displaying the test results. The resulting flow and pressure can be read and frozen on the display, or the flow and pressure readings can be continuously updated to reflect any changes in the flow and pressure being monitored.

Continuous reading
Each test carried out in the Read Continuous mode will be open ended. The instrument will continue to test and give a Pass or Fail indication until the instrument is reset.

Since the test is continuous a final result for communications or printing only occurs when the test is reset. When a result is required for communications or printing at other times, an external input may be used to trigger a result output at any time without ending the test. The display and lamps are updated every 300ms; communications and analogue outputs are typically updated >40 times per second.

Single reading
When the 'Start' button is pressed the stabilise and delay times are executed, then the flow and pressure readings are latched and displayed with the Pass or Fail lamps. Press the 'Reset' button to get back to a READY state. The functions menu has entries to automatically reset to ready on a pass and / or fail and to keep the result displayed for a preset time. Care must be taken to ensure that the readings will be stable when the result is taken.

Setting the Stabilise Time

The stabilise time is used to allow the pressure and flow readings to settle before the lamps are enabled.

To establish the stabilise time required when using the flow option, connect a good test item. Set the stabilise to time zero seconds. Set program data to read in continuous mode. Start the test while watching the flow display. Time how long it takes from pressing start until the flow and pressure readings have stabilised. Set this time in to the product data stabilise time.

External Interfacing

The Commissioning menu allows you to check the external inputs and outputs to verify wiring etc.

MENU DETAILS

Menu listings marked with * are only present with the enhanced firmware option.

Basic Operation

The front panel push buttons are used to view/set the FCO732 menu structure. Refer to the menu tree diagram below. The instrument's settings can be viewed whenever a test is not running by pressing the **ENTER** button. Settings may be protected by a security code. When security is enabled it is possible to view the settings but not to alter them.

```
MENU:
PRODUCT DATA
PROGRAM DATA
FUNCTIONS
AUTO ZERO
PRINTER SETTINGS
FBUS SETTINGS
SECURITY
COUNTERS
COMMISSIONING
```

Pressing the **ENTER** button from the main run-time display prompts you to select a menu:

The display has two lines. The top line shows a prompt. The bottom line shows the current entry in the menu list. Press **UP** or **DOWN** to scroll through the list.

Press **ENTER** to select the menu. Press **BACK** to exit back to the run-time display.

Some of the menus shown here may not be visible.

If you select the SECURITY menu when security is enabled you will be asked for a pass code before access is allowed to that menu. If security is disabled when you exit back to the run-time display a message will be shown as a reminder.

The enhanced version of the FCO732 has fifty sets of product data. When you select the Product Data menu the top line of the display flashes the product number: press **UP** or **DOWN** to choose the product to view/edit then press **ENTER** to select.

When you press **ENTER** the first parameter of the menu is displayed with the parameter name on the top line and its current value on the bottom line, e.g.

```
FLOW UNITS
L/M
```

Press **UP** or **DOWN** to scroll through the parameter list for this menu. Press **ENTER** to alter the value of the current selection. Press **BACK** to exit back to the menu list.

If you press **ENTER** when security is enabled you will be prompted for a pass code, otherwise the data field to be set starts blinking. For numeric and alphanumeric data this will be the left most character/digit. For option list data the entire option text will blink. The **UP** and **DOWN** buttons will increase or decrease the blinking field. For numeric data, overflow from 9 to 0 will cause the next decade to increment where appropriate.

For numeric and alphanumeric data, each press of the **RIGHT** button moves the blinking field to the right. When **ENTER** is pressed the display shows *SAVED* for a short period and the new data is accepted. The **LEFT** button moves the blinking field to the left, wrapping around after the left-most digit/character.

If no buttons are pressed for 15 seconds, setting is cancelled and the original value is restored.

Menu Navigation Diagram

```
PRODUCT DATA ──────  (SELECT PRODUCT*) ──────┬ PRODUCT ID
                                             ├ TEST TYPE
                                             ├ NOMINAL PRESSURE
                                             ├ PRESSURE TOLERANCE
                                             ├ PRESSURE LOW
PROGRAM DATA ─────┬ LEARN CALIBRATION        ├ PRESSURE HIGH
                  ├ CAL. CHECK TOLERANCE      ├ FLOW TYPE
                  ├ ALTER PRODUCT*            ├ NOMINAL FLOW
                  ├ NUMBER OF STEPS*          ├ FLOW TOLERANCE
                  ├ FLOW UNITS                ├ FLOW LOW
                  ├ PRESSURE UNITS            ├ FLOW HIGH
                  ├ FLOW LEVELS/TOLERANCE     ├ FILL TIME
                  ├ PRESS. LEVELS/TOLERANCE   ├ STABILISE TIME
                  ├ READ SINGLE/CONTINUOUS    ├ DELAY TIME
                  ├ FLOW DISPLAY CZ/LHZ       ├ VENT TIME
                  ├ FILTER                    ├ RELATIVE VISCOSITY
                  ├ ORIFICE PRESSURE          ├ CAL. CHECK VALUE
                  ├ ATMOSPHERIC PRESSURE      └ OUTPUT A-H*
                  ├ STANDARD TEMPERATURE
                  ├ JIG DELAY
                  └ CONTRAST


FUNCTIONS ───────┬ LANGUAGE
                 ├ RESET ON PASS
                 ├ RESET ON FAIL
                 ├ RESET DELAY
                 ├ REMOTE CONTROL          NOTE THAT SOME ITEMS
                 ├ TEMP. COMPENSATION      ARE NOT ALWAYS SHOWN
                 ├ PRESSURE CORRECTION
                 ├ HIGH RES. FLOW
                 ├ HIGH RES. PRESS.
                 ├ PERSISTENT MENUS        * Only available with
                 ├ END ON GROSS              the enhanced option
                 ├ CALIBRATION CHECK
                 ├ GLOBAL CAL. CHECK       *2 Purchase option only available
                 ├ OUTPUT 4-6                with the enhanced option
                 ├ OUTPUT 7-8*
                 ├ PNEUMATIC 1-2           *3 Purchase option
                 └ INPUT 3-5


AUTO ZERO ───────┬ AZ AT START
                 ├ TIMED AZ
                 └ AZ TIME


FBUS SETTINGS ───┬ PORT
                 ├ ID NUMBER
                 ├ BAUD RATE
                 ├ PARITY
                 └ REPLY DELAY


PRINTER SETTINGS ┬ PORT
                 ├ BAUD RATE
                 ├ PARITY
                 ├ AUTO LINE FEED
                 ├ MARGIN
                 ├ BLANK LINES
                 ├ SEND EOF
                 ├ SEND ON
                 ├ SEND AS
                 ├ SEND DATE *3
                 ├ SEND TIME *3
                 ├ SEND FCO732 ID
                 ├ SEND SEQUENCE RESULT*
                 ├ SEND PRODUCT ID
                 ├ SEND TEST COUNTER
                 ├ SEND STEP ID*
                 ├ SEND RESULT
                 ├ SEND PRESSURE
                 └ SEND FLOW


SECURITY ────────┬ LOCK ON/OFF
                 ├ PASS CODE
                 └ OFF BUTTON


TIME/DATE *3 ────┬ DATE
                 └ TIME


COUNTERS ────────┬ TEST
                 ├ PASS
                 ├ FAIL
                 └ RESET COUNTERS


COMMISSIONING ───┬ SET ZERO PRESSURE
                 ├ CALIBRATE PRESSURE
                 ├ CALIBRATE FLOW
                 ├ PRINT DATA ──────────────────┬ PRODUCT DATA
                 ├ INITIALISE DATA              ├ PROGRAM DATA
                 ├ SET FCO732 ID                ├ FUNCTIONS
                 ├ MAC ADDRESS *2               ├ AUTO ZERO
                 ├ LAN SETTINGS *2 ───┬         ├ PRINTER SETTINGS
                 ├ VIEW TEMPERATURE   ├ IP ADDRESS  └ COUNTERS
                 ├ VIEW ATM. PRESSURE *3 ├ SUBNET MASK
                 ├ CHECK OUTPUTS      ├ GATEWAY
                 ├ CHECK INPUTS       └ [SAVE]
                 ├ CHECK FBUS
                 ├ CHECK PRINTER
                 └ FLASH UPDATE
```

Product Data Menu

Identify the product to test and define the test pressure, fail levels, timings etc. for the test. The enhanced firmware option has 50 products. When you select the menu the top line of the display flashes to prompt you to select a product to view/edit.

PRODUCT ID

- You may assign a descriptive text identification of up to 16 characters to each product. This will be displayed on the top line of the LCD when the instrument is at standby.

TEST TYPE

- Define the type of test to perform.
- Options:
  - o **FLOW:** The pressure limits determine the pressure that the instrument will be allowed to test at. If the pressure is outside the limits the message P_LOW or P_HIGH will be displayed and the instrument will halt. The flow limits determine the flow at which the LOW, PASS or HIGH lamp will be illuminated. Setting the lower flow level to zero disables the low lamp with all flows below the high level resulting in a pass. Setting the high flow level to maximum disables the high fail limit with all flows above the low level resulting in a pass.
  - o **PRESSURE:** This is used for components that require testing using a constant flow with the test result based on the measured back pressure. The flow limits determine the flow that the instrument will be allowed to test at. If the flow is outside the limits the message F_LOW or F_HIGH will be displayed and the instrument will halt. The pressure limits determine the pressure at which the LOW, PASS or HIGH lamp will be illuminated. Setting the low pressure level to zero disables the low lamp with all pressures below the high level resulting in a pass. Setting the high pressure level to maximum disables the high fail limit with all pressures above the low level resulting in a pass

NOMINAL PRESSURE

- Only used with pressure tolerance or pressure correction.
- Set the nominal test pressure. This may be used in conjunction with the pressure tolerance (below). This is also the pressure that the flow will be corrected to when the PR. CORRECTION option in function data is set.

PR. TOLERANCE

- Only if 'pressure tolerance' is set in the program data menu.
- Sets the upper and lower test limits as a percentage band centred on the nominal pressure.

PR. LOW
PR. HIGH

- Only if 'pressure levels' is set in the program data menu.
- Set the lower and upper test limits for pressure.

FLOW TYPE

- Options:
    - **STD.:** The standard flow is displayed.
    - **JET:** The following correction is made:

$$JetFlow = Flow \times \sqrt{\frac{Pstd + Pt}{Patm + Pt} \times \frac{T}{Tstd}}$$

where: *Pstd* is the standard pressure
Pt is the test pressure
Patm is atmospheric pressure
T is the test temperature
Tstd is the standard temperature

NOMINAL FLOW

- Only if 'flow tolerance' is set in the program data menu.
- Set the flow that is to be the centre of the pass band.

FLOW TOL.

- Only if 'flow tolerance' is set in the program data menu.
- Set the upper and lower test limits as a percentage band centred on the nominal flow.

FL. LOW
FL. HIGH

- Only if 'flow levels' is set in the program data menu.
- Set the lower and upper test limits for flow.

FILL TIME

- This is used in conjunction with the optional pneumatic bypass output for applications where it is necessary to fill a test item faster than the restriction of the LFE allows. At the start of a test the LFE is bypassed. The bypass output is turned ON after the fill time expires, and OFF at the end of the test.
- The fill time may be set from 0 to 999.9 seconds.

STABILISE TIME

- Sets a time after the test has been started to allow for the readings to become stable before measurements are made. Care must be taken in determining the time. It is normally set up by repeatedly testing a known good test item and adjusting for the shortest time that gives repeatable readings.
- The stabilise time may be set from 0 to 999.9 seconds.
- Note: If the auto zero is active then it occurs after the stabilise time.

DELAY TIME

- The measured values are digitally filtered during the delay time and only displayed after the delay time has expired. This determines the end of a single-shot test. When the instrument is set for continuous reading the filtered pressure and flow values will be shown until reset.
- The delay time may be set from 0.2 to 999.9 seconds.

VENT TIME

- The vent time should be set if an external vent valve is fitted to the system. The time must be long enough to allow the pressure in the test item to decay to a safe level to ensure that the test item is not disconnected or unclamped while pressurised.

REL. VISCOS

- The calibration of the flow element used in this instrument is dependent on the viscosity of the gas being used. The viscosity of the gas is entered in units relative to air @ 20ºC.
- Set to 1.000 for use with air.
- See page 51 for the relative viscosity of commonly used gasses.

CAL. VALUE

- Only when the cal check option is enabled in Functions menu.
- This is the measured flow value that is automatically stored for the master gas jet when a 'learn calibration' test is run.

OUTPUTS A-H*

- Note that these outputs are a purchase option.
- Any combination of up to 8 outputs can be programmed for each product. These are typically used for BCD outputs, external regulator selection or jig control.
- Each of the eight outputs can be set off (0) or on (1), e.g. to turn outputs A and B on the setting will be "11000000".

Program Data Menu

The program data is common to all tests.

LEARN CAL.

- Only when the cal check option is enabled in Functions menu
- This allows the flow value of the master gas jet to be learned and stored at commissioning time.
- Options:
  - **NO:** Disables the 'learn calibration mode'
  - **YES:** When a calibration check is started, a 'learn calibration' test is run. This uses the options set in the program data and current product data to obtain a flow reading, but then stores the flow reading as the calibration for the test. Note: this option is automatically set back to 'No' when a successful learn is completed.

CAL. TOL.

- Only when the cal check option is enabled in Functions menu
- This limits the calibration-check gain change to a percentage of the learned value. If the gain change required to realign calibration exceeds this level then a fault is given.
- The limit may be set from 1.0% to 20.0%

ALTER PRODUCT*

- Enable the operator to select the product to use for testing.
- Options:
  - **NO**: The product to test can only be selected from the Product Data menu. This can be pass-code protected if required.
  - **FRONT PANEL**: The UP/DOWN buttons may be used to select the product to test from the main display when the instrument is at standby.
  - **BCD INPUT:** The BCD inputs select the product.

NUMBER OF STEPS*

- Normally set to 1 where the instrument runs just the test for the selected product.
- When set greater than 1 (up to 8) then simple sequence mode is enabled.
  - Sequence mode always starts from product 1.
  - At the end of the test for product 1 the instrument waits for a start signal before continuing with the next step using the next product data, and so on until the number of steps has completed or the instrument is reset.
  - Sequence mode always starts from product 1, so product selection from the front panel, BCD input, or communications is disabled.
  - If the RS232 output is used for printing results the Send On condition relates to the result of the entire sequence. If any step of the sequence fails then the sequence result is fail.

FLOW UNITS

- Choose the engineering units for the flow display. The units available depend upon the instrument range.

PRESSURE UNITS

- Choose the engineering units for the pressure display. The units available depend upon the instrument range.

FLOW

- Choose how the test limits for flow are to be set in the Product Data menu.
- Options:
  - o **LEVELS:** The upper and lower fail limits for the flow reading are set as two discrete levels
  - o **TOLERANCE:** The fail limits are set as a ± tolerance around a nominal value.

PRESSURE

- Choose how the test limits for pressure are to be set in the Product Data menu.
  - o **LEVELS:** The upper and lower fail limits for the pressure reading are set as two discrete levels
  - o **TOLERANCE:** The fail limits are set as a ± tolerance around a nominal value.

READ

- Select whether tests are single-shot or open-ended, reading continuously.
- Options:
  - o **SINGLE:** When a test is started and the stabilise time (if set) has expired the flow and pressure readings are filtered during the delay time and then held with the appropriate lamps displayed. Normally used for fast test times or test items that require no adjustment when testing.
  - o **CONTINUOUS:** The first reading is displayed after the stabilise and delay times have expired, then the flow and pressure readings are continuously updated and the state of the lamps changed accordingly until reset. Normally used where the test item can be adjusted to set the appropriate flow or pressure conditions.

FLOW DISPLAY

- Choose the format of the flow reading.
- Options:
  - o **C.Z.:** Centre Zero – positive and negative flows are displayed. Although the FCO732 is only calibrated for positive flow it does indicate approximate values for negative flow. This may be useful for rough checks, or as an indication of instability when measuring close to zero.
  - o **L.H.Z.:** Left Hand Zero only shows positive flow values. This may be beneficial if a particular test generates a negative flow that is not of interest.

FILTER

- Digital filtering may be applied to the pressure and flow readings to reduce the displayed noise due to turbulent pressure / flow signals. The filter time constant may be set between 0.0 and 9.9 seconds. Note that the response to a step change is approximately 5 times the time constant.

ORIFICE PRESSURE

- Define the pressure to be used for correction of the flow through the Laminar Flow Element back to atmospheric pressure.
- Options:
    - **EXT:** The external pressure measured from the sense port at the rear of the instrument is used to correct the flow readings. The pressure sense must be connected close to the Laminar Flow Element, otherwise the difference between the orifice pressure and the sense pressure will cause inaccuracy in the flow readings.
    - **ATM:** The orifice is assumed to be at the atmospheric pressure set in ATM. PRESS. below. No correction is made for the test pressure.

ATM. PRESS.

- This is used to set the current atmospheric pressure.
- Flow readings need to be corrected for absolute pressure. The value entered here is used to convert all gauge pressures to absolute. For the most accurate flow readings this value of atmospheric pressure should be corrected daily.
- The atmospheric pressure may be set from 700 to 1100mb.
- There is a purchase option for a built-in atmospheric pressure sensor that updates this value automatically.

STD. TEMP.

- The displayed flow reading is normally corrected back to standard temperature and pressure. The standard temperature is usually 20°C, but 15ºC is also common.
- The standard temperature can be changed here if required between 0ºC to 25ºC.

JIG DELAY.

- After the jig pilot is operated, there is a programmable time delay before the test starts to allow jig mechanisms to actuate.
- Options: Number from 0.0 to 9.9 seconds.

CONTRAST

- Adjust the display for differing viewing angles or conditions. Note that this feature is only available when appropriate hardware is fitted and so may not be displayed for older instruments that have been upgraded with new firmware.
- Options: Number from 1 to 16.

Function Data Menu

The function data menu sets major functions of the FCO732, typically to aid commissioning and interfacing to automatic jigging. Function data is common to all tests and need only be set once.

LANGUAGE

- Set the language for display and print-out messages.
- Options: ENGLISH, FRENCH, GERMAN, ITALIAN, SPANISH, POLISH, CZECH.

RESET ON PASS

- Only applies to single-shot tests.
- Options:
  - **NO:** When the test result is 'Pass' you must reset the test before a new test can be started. The test result is held until reset.
  - **YES:** Gives an automatic reset to 'Ready' if a Pass occurs. The result is held for a preset time before being cancelled. You may start a new test at any time.

RESET ON FAIL

- Only applies to single-shot tests.
- Options:
  - **NO:** When the test result is 'Fail' you must reset the test before a new test can be started. The test result is held until reset.
  - **YES:** Gives an automatic reset to 'Ready' if a Fail occurs. The result is held for a preset time before being cancelled. You may start a new test at any time.

RESET DELAY

- When automatic Reset On Pass or Reset On Fail is used the result lamps and outputs are held active at the end of a test for the time set here, then they are automatically cancelled. If you do not want to automatically cancel the lamps and outputs then set the time to zero.

REMOTE CONTROL

- Options:
  - **NO:** The front panel start/reset buttons are enabled and the external start/reset inputs are disabled.
  - **YES:** The external start/reset inputs can be used. The front panel start button is disabled, but front panel reset is still active.

TEMPERATURE COMPENSATION

- Options:
  - **NO:** This allows the instrument to be used in the event of a faulty temperature sensor or if flow measurement at working conditions instead of at standard conditions is required.
  - **YES:** Flow readings are corrected for the temperature of the gas to give flow readings that are standardised to the standard temperature set in the program data menu, typically 15ºC or 20ºC. Corrections are also made for viscosity changes so the relative viscosity must be set in the product data menu.

PRESSURE CORRECTION

- This function may be used to provide stable flow readings even when the pressure varies from the required test pressure.
- Options:
  - **NO:** The flow reading displayed is the true reading at the pressure being displayed.
  - **YES:** The flow reading is the equivalent flow reading at the pressure set in the product data. This reduces the sensitivity of the flow reading to pressure change. The correction is based on a square root law and assumes the test item follows this law. This option should not be used for gas appliances with internal regulators.

HIGH RESOLUTION FLOW

- Options;
  - **NO:** The instrument displays flow readings with 4 digits but the least significant digit is always zero.
  - **YES:** The instrument displays flow with 4 digits. This is the default setting.

HIGH RESOLUTION PRESSURE

- Options;
  - **NO:** The instrument displays pressure readings with 4 digits but the least significant digit is always zero.
  - **YES:** The instrument displays pressure with 4 digits. This is the default setting.

PERSISTENT MENUS

- Enable or disable the persistent menu feature.
- Options:
  - **NO:** Each time a menu is entered the first menu entry is displayed.
  - **YES:** Menu positions are remembered each time they are entered.

END ON GROSS

- Only applies to flow tests.
- Options:
  - **NO:** the test runs for the programmed test times.
  - **YES:** the test ends immediately if the test pressure goes out of limits during the stabilisation, delay or test times.

CAL. CHECK

- Enable or disable the calibration check feature.
- Options:
  - **NO:** Disable the calibration check feature and remove the calibration check entries from the product and program data menus.
  - **YES:** Enable calibration check feature and show the calibration check entries in the product and program data menus. The Calibration Check feature is detailed in a separate section in this guide - see page **53**.

GLOBAL CAL. CHECK*

- Enable or disable the global calibration check feature - see page **53**.
- Options:
  - o **NO:** The calibration check applies only to the current product data.
  - o **YES:** The gain change required for alignment of calibration is applied to all products. This is useful when several products or subassemblies are to be tested in succession with the same test gas.

OUTPUT 4-6 *(4-8 *)*

- These outputs are programmable by function for compatibility with older instruments and to accommodate features that are not available on the standard outputs.
- Options: Unassigned, Jig, Fail, -Fail, +Fail, Output A*, Output B*, Output C*, Output D*, Bypass, Vent, On, Pass.

PNEUMATIC 1-2

- There is a purchase option for two pneumatic pilot outputs. These are programmable for various functions but are usually used for Jig, LFE Bypass or Vent.
- Options: Unassigned, Jig, Fail, -Fail, +Fail, Output A*, Output B*, Output C*, Output D*, Bypass, Vent, On, Pass.

INPUT 3-5

- These inputs are programmable by function.
- Options:
  - o **Unassigned**: the input is unused.
  - o **Set Zero Pressure**: Zero the pressure transducer when the instrument is at 'Ready'. You must ensure that pressure is removed from the pressure sensor before using this. If permanently linked the instrument will re-zero every 10s.
  - o **Auto Zero**: Zero the flow transducer when the instrument is at 'Ready'.
  - o **Cal. Check**: Initiate a calibration check when the instrument is at 'Ready'.
  - o **Trigger Result**: By definition, continuous tests to not end and therefore do not give a final result for printing or communications. This input may be used to trigger the generation of a result. The test will continue to run as normal.
  - o **Vent Sensor**: the input is used to check a vent valve sensor. The sensor should be active when venting.
  - o **Jig Sensor**: When a test is started the FCO732 will wait for a signal from the jig before continuing. The jig delay (see the Program Data menu) starts after this signal is received.
  - o **Bypass Sensor**: the input is used to check a bypass valve sensor. The sensor should be active when the valve is bypassing the laminar flow element.

Auto Zero Menu

The FCO732 performs automatic zero compensation of its flow transducer to improve accuracy of flow readings. The abbreviation A.Z or A/Z is used to indicate auto-zero.

A.Z. AT START
- Options:
    - o **NO:** This option is disabled, to allow for faster testing.
    - o **YES:** The A/Z operates at the start of each test when the start button is pressed. This guarantees the transducer zero is correct for every test.

TIMED A.Z.
- Options:
    - o **NO:** For fast cycle test times or applications where it is not acceptable to have an auto zero function during a test, the timed auto zero should be disabled. To ensure the transducers are zeroed periodically, A.Z. AT START should be enabled.
    - o **YES:** The transducer is guaranteed to be auto zeroed at a regular time interval. This ensures that the zero drift on the transducer is minimal, however when the auto zero function occurs, the instrument's display is frozen for approximately two seconds. This freezing of the display may cause difficulty in automated testing.

A.Z. TIME
- To ensure the instrument does not go for a long period of time without auto-zeroing a timer can be set. The time period resets whenever an auto zero occurs. The timer is only active if the TIMED A.Z. option is enabled.
- The time interval between auto-zeros can be set from 30 seconds to 999 seconds.

Fbus Settings Menu

The FCO732 can communicate with a computer/PLC using the Fbus protocol. Application software is available from Furness Controls such as the FCS432 Fbus Utility and the FCS487 data logger. The Fbus protocol is documented separately from this guide.

Select the Fbus communications port and configure it to match the device that the FCO732 is connected to.

PORT

- Options:
    - o **DISABLED**: The print function is not used.
    - o **RS232**: Uses the 9-way D rear panel connector.
    - o **RS485**: (optional) uses the rear screw terminal connector
    - o **LAN**: (optional, enhanced version only) uses the Ethernet connector.

ID NUMBER

- Assign a unique identification number to this instrument for Fbus communications in the range 01 to 99.

BAUD

- The baud rate is the speed that data is sent via the serial ports. The baud rate must be the same on the FCO732 and device being connected.
    - o Newer firmware does not display this option for LAN.
    - o For older firmware the baud rate must be set to 115200 for LAN.
- Options: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200.

PARITY

- Select the type of error checking used when sending data via the serial ports. The parity must be the same on the FCO732 and device being used. The serial data is formatted for one start bit, seven or eight data bits, one parity bit and one stop bit.
    - o Newer firmware does not display this option for LAN.
    - o For older firmware this must be set to 8,NONE for LAN.
- Options:
    - o **8,NONE:**   8 data bits and no parity.
    - o **7,ODD:**   7 data bits and odd parity.
    - o **7,EVEN:**   7 data bits and even parity.
    - o **8,ODD:**   8 data bits and odd parity.
    - o **8,EVEN:**   8 data bits and even parity.

REPLY DELAY

- This may be used to delay the instrument's response to a communications command, typically for use with 2-wire RS485 connections to allows the master device some time to disable its transmitter and prepare for the reply.
- The delay may be set from 0 to 50ms.

Printer Settings Menu

Select the printer port and configure it to match the device that the FCO732 is to be connected to. The printed output may also be useful for simple PLC or computer interfacing.

PORT
- Options:
    - **DISABLED**: The print function is not used.
    - **RS232**: Uses the 9-way D rear panel connector.
    - **RS485**: (optional) uses the rear screw terminal connector
    - **LAN**: (optional, enhanced version only) uses the Ethernet connector.

BAUD
- The baud rate is the speed that data is sent via the serial ports. The baud rate must be the same on the FCO732 and device being connected.
    - Newer firmware does not display this option for LAN.
    - For older firmware the baud rate must be set to 115200 for LAN.
- Options: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200.

PARITY
- Select the type of error checking used when sending data via the serial ports. The parity must be the same on the FCO732 and device being used. The serial data is formatted for one start bit, seven or eight data bits, one parity bit and one stop bit.
    - Newer firmware does not display this option for LAN.
    - For older firmware this must be set to 8,NONE for LAN.
- Options:
    - **8,NONE:**   8 data bits and no parity.
    - **7,ODD:**   7 data bits and odd parity.
    - **7,EVEN:**   7 data bits and even parity.
    - **8,ODD:**   8 data bits and odd parity.
    - **8,EVEN:**   8 data bits and even parity.

AUTO LINE FEED
- Set for compatibility with printers that add spacing between lines of print, or for printing to a PC.
- Options:
    - **NO:** The FCO732 does not send a line-feed at the end of a line. If the printer does not add a line feed then all lines of print are printed on top of each other.
    - **YES:** At the end of every print line the FCO732 sends a line-feed. If the printer also has auto line-feed turned on it prints double-spaced. This is the usual setting for connection to a PC.

MARGIN
- Allows custom printed data to be positioned horizontally on the paper, for example to line up labels. Up to 60 character spaces may be inserted.

BLANK LINES
- Prints a number of blank lines after custom printed result data. This allows results from consecutive tests to be separated and can also be used to align labels when using a label printer. Up to 20 blank lines may be added.

SEND EOF

- When a PC or PLC is capturing printed data from the FCO732 it may be useful to add an "End Of File" character at the end of the printed data. The EOF character may be represented as <Ctrl Z>, 0x1a, chr$(26) etc.
- Options: NO, YES.

SEND ON

- Determine the conditions that allow the data to be printed at the end of a test.
- Options:
  - **RESULT:** The data is printed at the end of the test.
  - **PASS:** The data is only printed if the test resulted in a pass.
  - **FAIL:** The data is only printed if the test resulted in a fail.

SEND AS

- Select the format of the printed data.
- Options:
  - **FIXED:** the data is sent in a single line of ASCII code in a set format consisting of product number, result, pressure value, and flow value. The product number is always 01 for the single test version of the FCO732. CR is always sent, with LF and EOF optional, as configured.
  - In sequence mode each step is printed on a new line.

Product	Pass/Fail	Test Press.	T. P Units	Flow	Flow Units	Termination
xxx	xx	xxxxxxx	xxxxx	xxxxxxx	xxxx	x x x
01,	P,	0.400,	KPA ,	-0.1,	L/M	CR LF EOF

  - **CUSTOM 1:** This allows the printed result to be customised using the settings below. The print-out consists of a header block followed by one or more step results (only the enhanced version supports more than one step). Each value is preceded by a label, e.g. "PRESSURE   123mB".
  - **CUSTOM 2:** As for Custom 1, but without the labels, e.g. "123mB". This is useful for programmable printers that process the output before printing.
  - **ZPL II FORM**: This is for use with Zebra® printers using the ZPL II® language. The printer must be configured to use a predefined form. The FCO732's printed output supplies the data to fill in the form. The custom settings below determine which values are sent to the form.

The following menu entries define the custom format.

Header section:
SEND DATE

- Only if the real time clock option is fitted.
- Options: NO, YES.

SEND TIME

- Only if the real time clock option is fitted.
- Options: NO, YES.

SEND FCO732 ID
- Print the FCO732 ID from the Program Data menu.
- Options: NO, YES

SEND SEQUENCE RESULT*
- Print the sequence result as PASS or FAIL.
- Options: NO, YES.

SEND PRODUCT ID
- Print the product ID that is set in the product data menu as part of the header.
- Options: NO, YES.

SEND TEST CNTR.
- Print the accumulative test counter as part of the header.
- Options: NO, YES.

Step Section (repeated for all steps in sequence mode)**:**

SEND STEP ID*
- Print the Product ID for each step of the sequence in the custom format.
- Options: NO, YES.

SEND RESULT
- Print the result of the test in the custom format.
- Options: NO, YES.

SEND PRESSURE
- Print the test pressure and engineering units in the custom format.
- Options: NO, YES.

SEND FLOW
- Print the flow value and engineering units in the custom format.
- Options: NO, YES.

Security Menu

The FCO732 may be configured to stop unauthorised changes to the test parameters. If you select this menu when the instrument is locked you will be asked to enter the security code before continuing.

LOCK?
- Lock or unlock data entry. When locked, you will be asked for a security code before changing data. When unlocked you are reminded each time you exit the menu system.
- Options: NO, YES.

SECURITY CODE
- Allows the user to set a personal security code.
- Options: 4 digit numeric password from 0000 to 9999.
- If the code is forgotten it can be checked or changed via Fbus communications, or Furness Controls service personnel.

OFF BUTTON
- This allows the off button function to be enabled or disabled.
- Options:
  - **NO:** The off button is disabled. The instrument can only be powered down by removing the external power.
  - **YES:** The off button is enabled and the instrument may be shut down.

Time & Date

This is a purchase option. When fitted, it allows printed results to include the time and date. If the option is not fitted then this menu will not be displayed and the options to print time and date are not given.

Date
- The date is set in the format yyyy-mm-dd.

Time
- The time is set in 24 hour format as hh:mm:ss.

Counters Menu

The FCO732 maintains test result counters to aid production line analysis. The counters may be viewed or reset to zero in this menu. The counters automatically reset to zero when the total test count exceeds 999999.

TEST
- Displays the total number of tests executed since the counters were last reset.

PASS
- Displays the number of tests that passed along with the pass rate in percent.

FAIL
- Displays the number of tests that failed along with the failure rate in percent.

RESET COUNTERS
- The counters may be reset to zero. You will be prompted for confirmation before the counters are cleared. If you select this menu when the instrument is locked you will be asked to enter the security code before continuing.

Commissioning Menu

This menu is only visible when security is unlocked. It allows the user to perform functions that are outside the scope of the normal operation, typically for commissioning and diagnostic purposes.

SET ZERO PRESS.

- It is possible for the zero point of the test pressure transducer to drift over time or with large temperature changes. This menu allows any drift that may occur to be corrected.
- Options:
  - **NO:** Exit with no change.
  - **YES:** Correct the zero offset.
    Before selecting 'Yes', **TURN OFF THE AIR SUPPLY TO THE FCO732**. The instrument should have been switched on for at least 15 minutes.

CALIBRATE PRESSURE

- Normal calibration is carried out at the factory and the information is stored in the instrument (in EEPROM). This information cannot be altered. However this menu allows up to ±10% adjustment for field recalibration. Since the original calibration is not changed it can be reset as required.
  - Initially the pressure reading is displayed flashing. Use the **UP** and **DOWN** buttons to change the reading to match your calibration device, and then press **ENTER** to continue.
  - The resulting percentage change from original calibration is then displayed and may be edited. Set to zero for original calibration.
  - Press **ENTER** again to finish.

CALIBRATE FLOW

- Normal calibration is carried out at the factory and the information stored in the instrument (in EEPROM). This information cannot be altered. However this menu allows numeric entry of up to ±10% adjustment for field recalibration. Set to zero for original factory calibration.

PRINT DATA

- This allows the instrument's settings to be printed. Note that this menu option will not appear if the printer port is disabled.
- Options: Sub menu:
  - **PRODUCT DATA**
  - **PROGRAM DATA**
  - **FUNCTIONS**
  - **AUTO ZERO**
  - **PRINTER SETTINGS**
  - **COUNTERS**
- Press enter to print the data. '*' is displayed while printing. Press the **BACK** button to abort printing.

INITIALISE DATA

- This is used to reset all data menu settings back to factory default values. You will be prompted for confirmation before any data is changed.
- Options: NO, YES

FCO732 ID

- Assign an 8-character identifying description/code to this FCO732.
  The ID defaults to a value based on the instrument's serial number but can be changed if required. It may be included in printed results.
- Note that this value does not get sent or received by Fbus Communications as part of the instrument settings. It can only be set via this menu.

MAC ADDRESS*

- Only displayed if the LAN option is fitted to view the instrument's MAC address.

LAN SETTINGS*

- Only displayed if the LAN option is fitted to view/set the instrument's IP address, subnet mask, and gateway. Note that you must select the [SAVE] option to action any changes.

VIEW TEMPERATURE

- Shows the temperature measured by the sensor attached to the flow element in ºC. If the sensor is disconnected the message "TEMPERATURE HIGH" is displayed.

VIEW ATM. PRESS.

- Only displayed if the optional pressure sensor is fitted.
- The atmospheric pressure is displayed in mB.

CHECK OUTPUTS

- Allows each of the instrument's outputs to be activated and deactivated.
- Use the **UP** and **DOWN** buttons to select an output. Press the **ENTER** button to turn the selected output on/off. The output is turned off when another is selected. Press the **BACK** button to exit the check.

CHECK INPUTS

- Allows the status of the instrument's inputs to be checked.
- Press the **BACK** button to exit.
- The top line of the display labels sixteen inputs as 1-9, A-G. The bottom line of the display shows which input signals are active. For example, the display below shows that inputs 1 and 12 are active:

1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G
I											I				

- Note that the remote reset input is fail-safe so the instrument is reset when the signal is inactive, and NOT reset when the signal is active.

Display	Input	Function
1	1	NOT Remote Reset (fail safe operation)
2	2	Remote Start
3	3	Auto Zero Demand (Programmable)
4	4	Calibration Check (Programmable)
5	5	Result Trigger (Programmable)
6	6	BCD 40 for enhanced option
7	7	BCD 20 for enhanced option
8	8	BCD 10 for enhanced option
9	9	BCD 8 for enhanced option
A	10	BCD 4 for enhanced option
B	11	BCD 2 for enhanced option
C	12	BCD 1 for enhanced option
D		Reserved
E		Reserved
F		Reserved
G		Reserved

CHECK FBUS

- Monitors Fbus Communications on the RS232 or RS485 or LAN port (but not the USB port).
- Only displayed when Fbus Communication is enabled.
- Press the **BACK** button to exit.

R		I	D		E	N	Q			O	K		E	r	r
+		0	1		M	0	0	0		Y					

Receiving data
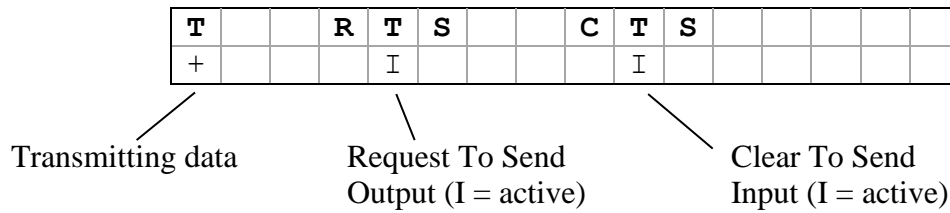Fbus ID for received data

command (CMD)
or enquiry (ENQ)

Y = accepted
N = not accepted
blank = not for this instrument

Fbus tag of rejected data

CHECK PRINTER

- Monitors printer status on the RS232 port.
- Only displayed when the printer has been enabled on the RS232 port as this is the only port with hardware handshake.
- Press the **BACK** button to exit.

T			R	T	S			C	T	S					
+				I					I						

Transmitting data   Request To Send   Clear To Send
                                 Output (I = active)   Input (I = active)

When the instrument has data to send it will activate the RTS signal. It will not send the data until it gets a CTS signal from the receiving equipment (printer, PLC etc).

FLASH UPDATE

- This initiates a product firmware upgrade by downloading the new firmware from a PC using the RS232 or USB-B port. You will be prompted for confirmation before the update is started.
- Options:
  - **NO:** Exit with no changes.
  - **YES:** Restarts the FCO732 in Flash Update mode. Once this procedure is started the instrument is commanded from the RS232 or USB port. To cancel Flash Update mode you must remove power from the instrument, or command it from the RS232/USB.

INPUT/OUTPUT CONNECTORS

Status Outputs

This detachable tension clamp terminal block accepts wire sizes from 0.08mm^2 to 1.0mm^2 and requires a small flat bladed screwdriver (2.5mm max.) to insert and remove wires. Note that there are no screws - the screwdriver blade is simply pushed in to release the tension clamp.

Standard

```
 24V  ◎ ▥▥ ◎  0V
  +   ◎ ▥▥ ◎  0V
  2   ◎ ▥▥ ◎  1
  4   ◎ ▥▥ ◎  3
  6   ◎ ▥▥ ◎  5
```

Optional

```
 24V  ◎ ▥▥ ◎  0V
  +   ◎ ▥▥ ◎  0V
  2   ◎ ▥▥ ◎  1
  4   ◎ ▥▥ ◎  3
  6   ◎ ▥▥ ◎  5
  8   ◎ ▥▥ ◎  7
 10   ◎ ▥▥ ◎  9
 12   ◎ ▥▥ ◎  11
 14   ◎ ▥▥ ◎  13
 16   ◎ ▥▥ ◎  15
```

Pin	Function
24V	Power supply 24VDC (Internally connected to power connector 24V pin)
0V	Power supply 0V (Internally connected to power connector 0V pin)
+	Output positive supply, typically linked to +24V
1	Ready: instrument is ready to start a test
2	Fault: instrument is unable to start a test due to a fault condition
3	Pass: test result
4	Fail: test result (reprogrammable)
5	Programmable function.
6	Jig (reprogrammable)
7	Programmable function. Enhanced option only.
8	Programmable function. Enhanced option only.
9	Output A. Programmable by product. Enhanced option only.
10	Output B. Programmable by product. Enhanced option only.
11	Output C. Programmable by product. Enhanced option only.
12	Output D. Programmable by product. Enhanced option only.
13	Output E. Programmable by product. Enhanced option only.
14	Output F. Programmable by product. Enhanced option only.
15	Output G. Programmable by product. Enhanced option only.
16	Output H. Programmable by product. Enhanced option only.

The status output transistors switch the positive supply connected to the '+' pin to give an active high signal. They require a DC power supply on the + and 0V pins to operate; this is typically the same power supply as the main instrument supply, but could be separate when it is necessary to switch a higher or lower voltage.

The voltage between the + and 0V pins must be within the range of 12 to 45VDC. Ensure correct polarity. Each output can source up to 120mA. If higher voltage or current is required use an external relay.

Control Inputs

This detachable tension clamp terminal block accepts wire sizes from 0.08mm^2 to 1.0mm^2 and requires a small flat bladed screwdriver (2.5mm max.) to insert and remove wires.

Standard	**Pin**	**Function**
4 ... 5	24V	Power supply 24VDC (internally connected to power connector 24V pin)
2 ... 3	0V	Power supply 0V (internally connected to power connector 0V pin)
COM ... 1	COM	Common connection for all inputs
24V ... 0V	1	Reset
	2	Start
	3	Auto Zero Demand (at 'Ready' only, reprogrammable).
Optional	4	Calibration Check (at 'Ready' only, reprogrammable).
	5	Result Trigger (for continuous test mode, reprogrammable).
12 ... COM		
10 ... 11	6	BCD 40. Enhanced option only.
8 ... 9	7	BCD 20. Enhanced option only.
6 ... 7	8	BCD 10. Enhanced option only.
4 ... 5	9	BCD 8. Enhanced option only.
2 ... 3	10	BCD 4. Enhanced option only.
COM ... 1	11	BCD 2. Enhanced option only.
24V ... 0V	12	BCD 1. Enhanced option only.

The opto-coupled inputs can be connected to active high or active low circuits since the common can be either the positive or negative supply. The external 24V DC instrument supply would typically be used for the input circuits, however any DC signal from 5V to 24V could be used.

Note that the reset input is fail-safe so that it must be made before instrument can start when remote control is enabled (Functions menu). See the input connection method diagrams in the Interfacing section of this guide.

Analogue Output (optional)

The flow signal may be output as either 0-5V or 0-10V depending upon the order code. The output is typically updated >40 times per second.

PIN	DESCRIPTION
1	0V
2	Flow Signal
3	N/C
4	+24V
5	Pressure Signal
6	N/C
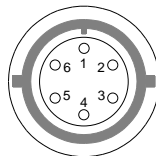
View Looking At Rear Panel

RS232 Output

Note: RS232 connection to the instrument must be made using screened cable with the screen connected to a metallic shell of the 'D' connector at the instrument end.

View looking at rear panel

9-way 'D' plug
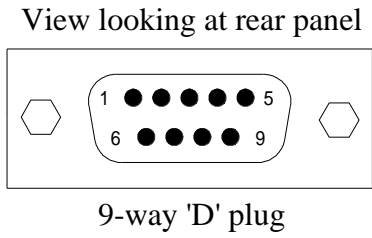
PIN	INPUT/OUTPUT
1	No connection
2	Rx receive (input)
3	Tx Transmit (output)
4	DTR Data Terminal ready (output)
5	Ground
6	No connection
7	RTS Request to send (output)
8	CTS Clear to send (input)
9	No connection

Typical Fbus Connections

When used for Fbus Communications, no handshake signals are used. The only connections required are Tx, Rx and GND. However, a commonly available cross-over cable is often used for convenience.

Typical Printer Connections

When used for printer output, the CTS handshake signal is required by the instrument to allow data to be sent. Only Tx, CTS and GND connections are required. However, a commonly available cross-over cable is often used to provide RTS/CTS handshaking, particularly with a PC or PLC. When used with a serial printer, you must check the printer's specification because printer connections can vary significantly from device to device.

Example cross-over cable, often known as a Null Modem cable:

FCO732 D Connector	COMPUTER D Connector
9-way	9-way

2	Rx	———————	3	Tx
3	Tx	———————	2	Rx
5	GND	———————	5	GND
7	RTS	———————	8	CTS
8	CTS	———————	7	RTS
4	DTR	———————	6	DSR
6	DSR	———————	4	DTR

RS485 Output (optional)

Note: RS485 connection to the instrument must be made using screened cable with the screen connected to the chassis of the computer/PLC.
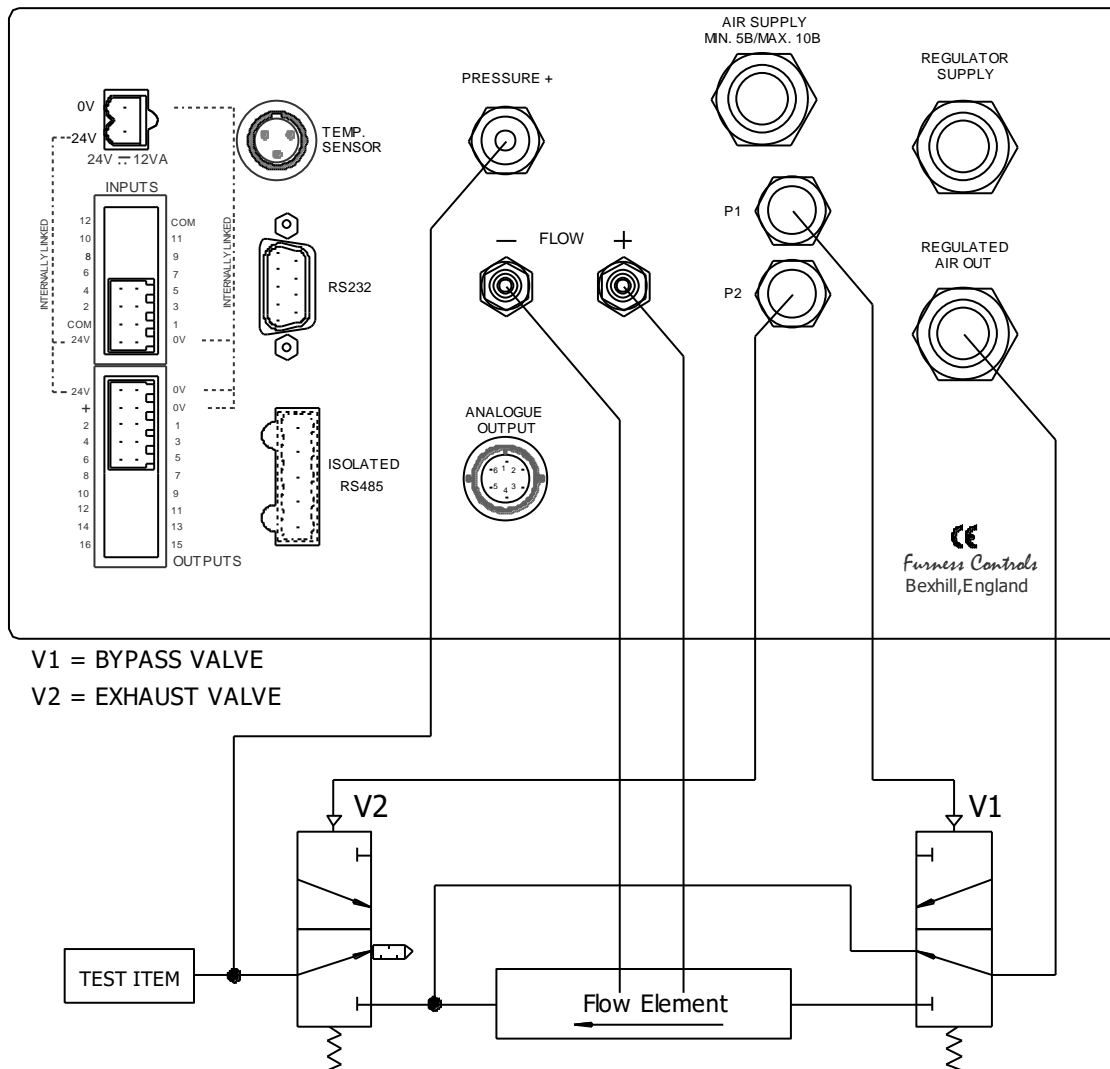
New style connector

View looking at rear panel

5-way screw terminal

PIN	INPUT / OUTPUT
5	GND
4	RX B
3	RX A
2	TX B
1	TX A

Old style connector

View looking at rear panel

9-way 'D' socket

PIN	INPUT / OUTPUT
1	GND
2	RX A
3	TX B
4	GND
5	GND
6	GND
7	RX B
8	TX A
9	GND
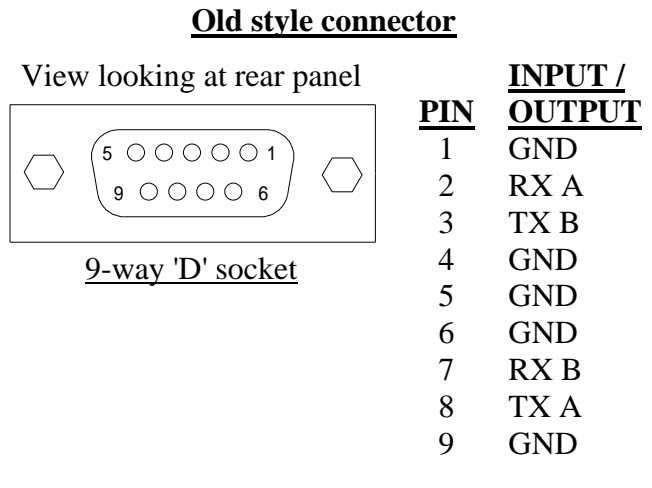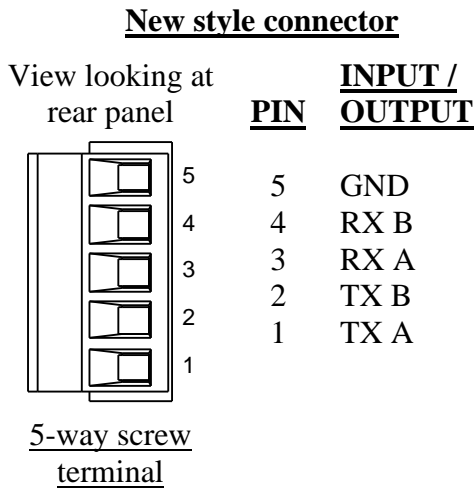
Typical RS485 Connections

Multi-drop 4 wire RS485 system showing adaptors to connect to the RS232 ports of a PC and other Furness Controls equipment.

PC
9 way D Plug
RS232
9 way D Socket
K2 Adaptor
SW2 & SW3 are ON
All other switches OFF.
9 way D Socket
8 3 2 7 5
TX A TX B RX A RX B GND

7xx series instrument
RS485
Screw terminals
1 2 3 4 5
TX A TX B RX A RX B GND

73x series instrument (pre 2006)
RS485
9 way D Socket
8 3 2 7 5
TX A TX B RX A RX B GND

2xx/7xx series instrument
RS232
9 way D Plug
RS232
9 way D Socket
K2 Adaptor
SW2 is ON
All other switches OFF.
9 way D Socket
8 3 2 7 5
TX A TX B RX A RX B GND

Twisted pair
Screen

K2-TB Adaptor
Screw terminals
1 2 3 4 5
TX A TX B RX A RX B GND

The K2-TB adaptor uses screw terminals instead of a 9-way D connector to simplify the wiring.

Devices should be connected using screened twisted pair cable, which has at least two twisted pairs. Either the screen or an additional wire can be used to connect the ground pins.
Cables can be either looped in and out of the connectors, or terminal boxes can be used to allow a spur to be taken from the main cable to each device.

Interfacing To A Jig

Bypass and Vent valve configuration

V1 = BYPASS VALVE
V2 = EXHAUST VALVE

- In the Function menu, set pneumatic output P1 = "Bypass" and P2 = "Vent"

- The flow element is bypassed in standby and during fill. The valve is turned on during stabilise and test stages.

- The Stabilise time must be set long enough for a leak to be established after the bypass valve is turned on.

Electrical input connection methods

ACTIVE HIGH CIRCUITS

SWITCH OR RELAY CONTACTS

PNP PROXIMITY SWITCH/TRANSISTOR DRIVE

ACTIVE LOW CIRCUITS

SWITCH OR RELAY CONTACTS

NPN PROXIMITY SWITCH/TRANSISTOR DRIVE
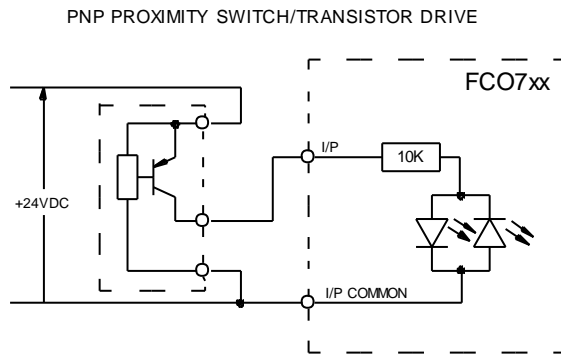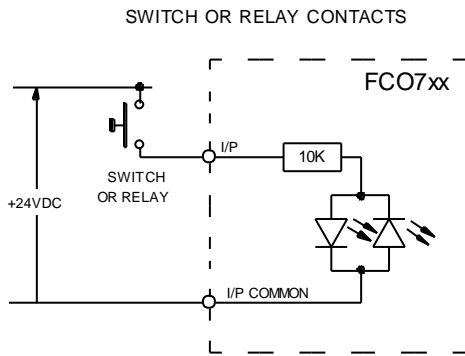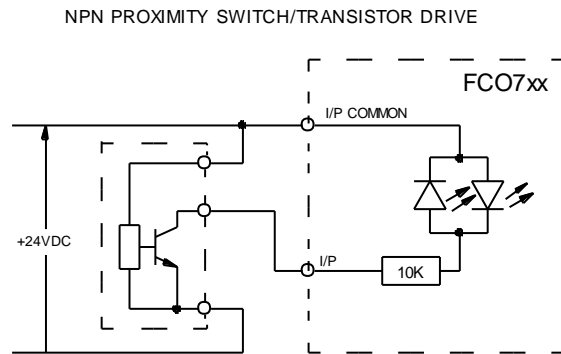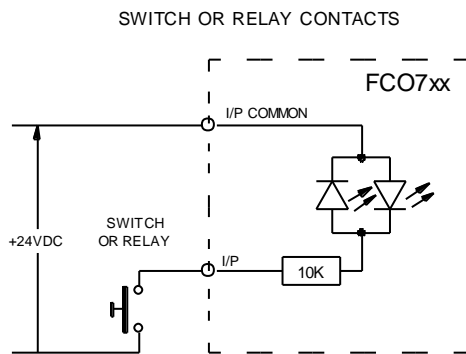
Control Input Circuits

Separate buttons:

Note that the reset input is fail-safe and must therefore use a normally closed switch.
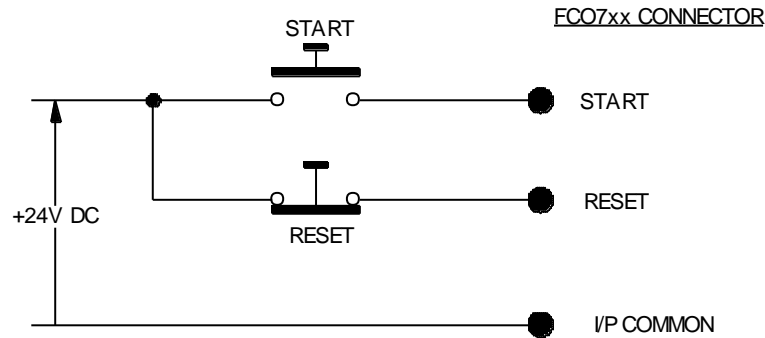
If these signals are supplied from a PLC the Ready signal can be used to check that the start and reset signals have been actioned, otherwise the minimum timings below should be observed.
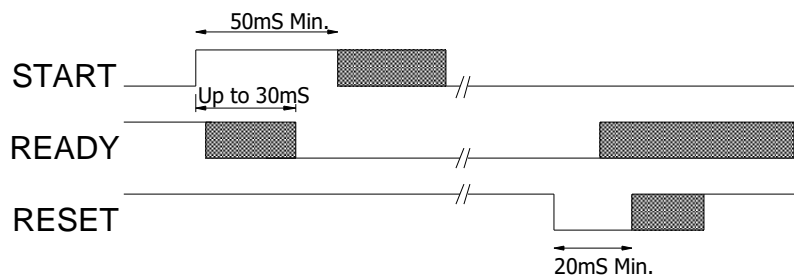
Single Switch:

This method cannot use the auto-reset or continue-on-start features. The start signal is permanently connected and the instrument is controlled by the reset input. The reset input is fail-safe so the position shown is for the reset state. The switch needs to be in the start position for the whole of the test. At the end of the test the switch may be returned to the reset position. For continuous test mode, connect the START input to the instrument's READY output instead of +24V and switch RESET to +24V as shown.

Connecting to a PLC

FCO7xx   PLC

INTERNAL +24V DC

CONNECT THE OUTPUT
SUPPLY AS APPROPRIATE

+

+24V DC

O/P   I/P

0V   0V

PLC WITH ACTIVE HIGH I/P

FCO7xx   PLC

INTERNAL +24V DC

CONNECT THE OUTPUT
SUPPLY AS APPROPRIATE

+

+24V DC

O/P   I/P

0V   0V

PLC WITH ACTIVE LOW I/P

FCO7xx

FAIL

OUTPUTS CAN BE CONNECTED
TOGETHER AS SHOWN TO GIVE
AN 'OR' FUNCTION.

FAIL O/P

FAULT
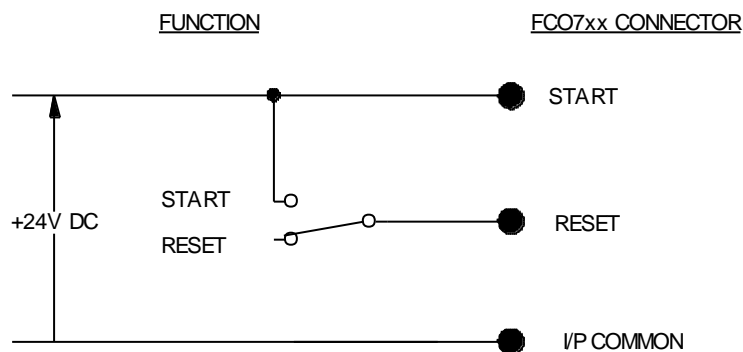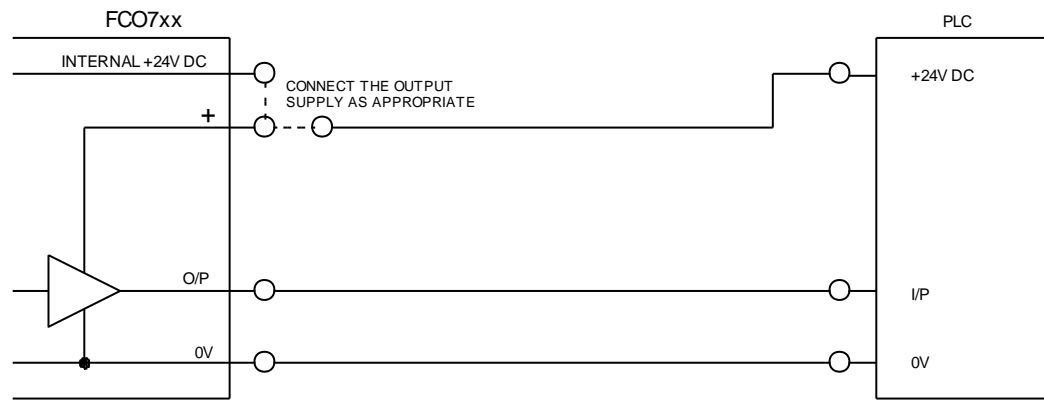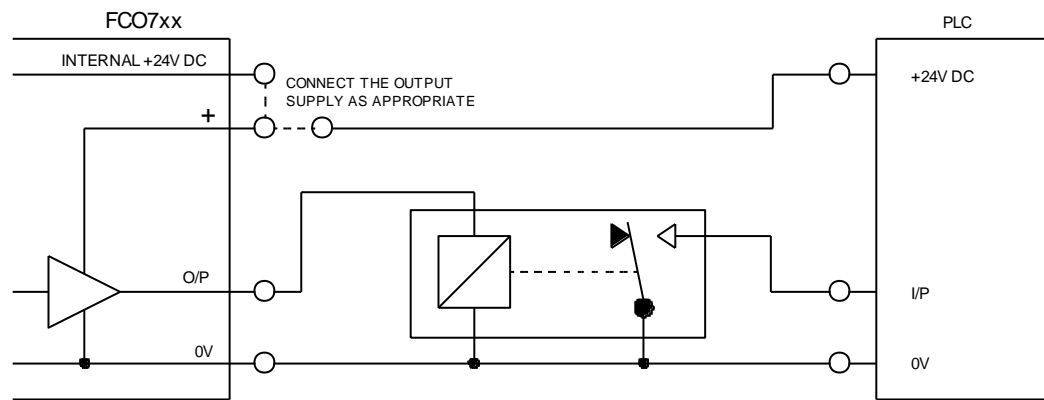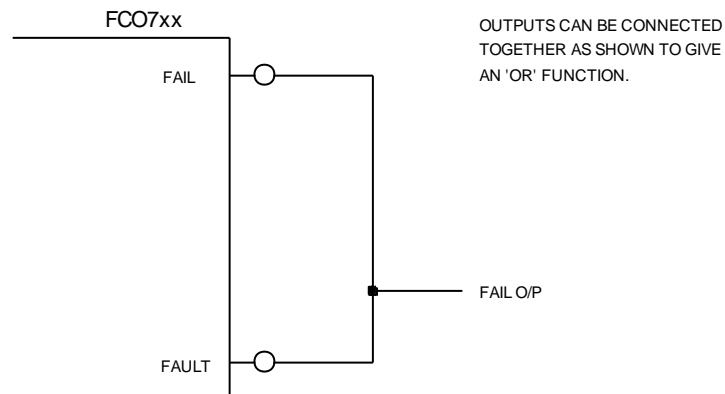
ERROR MESSAGES

A number of error messages can be displayed in the event of a system or hardware failure.

MESSAGE: **++++**
Indicates flow or pressure is over-range.

MESSAGE: **----**
Indicates flow or pressure is under-range.

MESSAGE: **TEMPERATURE HIGH**
The temperature is above 50ºC or there is a poor connection to the external sensor, or the sensor is faulty.

MESSAGE: **TEMPERATURE LOW**
The temperature is below 0ºC or the sensor is faulty.

MESSAGE: **DATA CORRUPT**
The instrument memory has been corrupted. If the instrument has been powered down for a long time the memory backup battery may be discharged – it will recharge while the instrument is powered. Check the data in each menu or choose Initialise Data in the commissioning menu. User Calibration is not reset by Initialise Data so if the user calibration is corrupt it is necessary to reset it manually.

MESSAGE: **FLOW ZERO FAULT**
Indicates that the zero output of the flow transducer is beyond the automatic zero limits. The transducer assembly requires re-zeroing; if this is beyond adjustment look for damage or contact your supplier.

MESSAGE: **PR. ZERO FAULT**
Indicates that the zero output of the pressure transducer is beyond the allowable 7.5% limit when attempting zero using the Set Zero Pressure menu. This is often simply an indication that the air supply had not been turned off when zeroing. If this is not the case then the transducer assembly requires re-zeroing; if this is beyond adjustment look for damage or contact your supplier.

MESSAGE: **ADC FAULT**
This indicates a fault in the analogue to digital conversion. Contact your supplier.

MESSAGE: **EEPROM FAULT**
The calibration figures stored in EEPROM may have been corrupted. Contact your supplier.

MESSAGE: **T. SENSOR FAULT**
The internal temperature sensor has failed. Contact your supplier.

MESSAGE: **V.V. STUCK ON**
A vent valve sensor has been configured in the functions menu. The valve may be stuck in the energised position - ensure that the supply pressure is not greater than 10 bar. The valve sensor may be broken or not fitted correctly.

MESSAGE: **V.V. STUCK OFF**
A vent valve sensor has been configured in the functions menu. The valve may be stuck in the de-energised position or the valve sensor may be broken or not fitted correctly.

MESSAGE: **B.V. STUCK ON**
A bypass valve sensor has been configured in the functions menu. The valve may be stuck in the energised position - ensure that the supply pressure is not greater than 10 bar. The valve sensor may be broken or not fitted correctly.

MESSAGE: **B.V. STUCK OFF**
A bypass valve sensor has been configured in the functions menu. The valve may be stuck in the de-energised position or the valve sensor may be broken or not fitted correctly.

MESSAGE: **JIG OPEN**
A jig sensor has been configured in the functions menu. The instrument is waiting for the sensor to indicate that the jig has closed.

MESSAGE: **CAL LOW FAULT**
In learn mode: Whilst trying to learn the flow value of the master gas jet, the flow reading obtained was less than 2.5% of the instruments measuring range. A master jet with a higher flow rate is required for this pressure and gas type.
In calibration check mode: The flow reading obtained during a calibration check was less than 10% of the learnt calibration value. This may be due to the wrong gas pressure or type being used for the current test. If the gas type has just been changed, there may be a mixture of gasses in the system.

MESSAGE: **CAL HIGH FAULT**
In learn mode: Whilst trying to learn the flow value of the master gas jet, the flow reading obtained was greater than 90% of the instruments measuring range. A master jet with a lower flow rate is required for this pressure and gas type.
In calibration check mode: The flow reading obtained during a calibration check was greater than 10% of the learnt calibration value. This may be due to the wrong gas pressure or type being used for the current test. If the gas type has just been changed, there may be a mixture of gasses in the system.

MESSAGE: **BCD I.P. FAULT**
BCD inputs are enabled in the Functions menu (enhanced version only) and the inputs are set to an invalid BCD value. You can check the inputs using the commissioning menu. Note if no connections are made to the BCD inputs, this will show the BCD input fault, as test number zero is invalid.

MESSAGE: **NOT CONFIGURED: LAN**
The LAN adaptor has not been configured correctly. Please refer to the separate LAN installation guide.

MESSAGE: **UNLICENSED FIRMWARE**
This will occur if the instrument firmware has been updated from a standard version to an enhanced version. The enhanced firmware is a cost option and requires a license to be applied before it can be used. To clear this message, either replace the instrument firmware with the standard version or apply a license provided by Furness Controls.

TROUBLE SHOOTING

PROBLEM: THE FRONT PANEL START BUTTON DOES NOT WORK
Cause: The instrument is set for remote control.
Action: Disable remote control in the Functions menu ➜ Remote Control.

PROBLEM: REMOTE CONTROL START DOES NOT WORK
Cause: The remote control inputs have not been enabled.
Action: Enable remote control in the Functions menu ➜ Remote Control.

Cause: The remote control reset signal is wired incorrectly.
Action: The reset signal must be wired. If it is left open circuit the instrument is kept
                in a reset state.

PROBLEM: INCORRECT TEST PRESSURE DISPLAYED.

Cause: The pressure was zeroed in the commissioning menu when a pressure was
                applied.
Action: Use the commissioning menu to reset the pressure zero.

USING GASSES OTHER THAN AIR

The calibration of the FCO732 is dependent on the viscosity of the gas but not on the gas density. However the density of the gas can affect the maximum flow for the FCO732 before non linearity occurs.

There are two causes of density change, the first is the gas type, and the second is the gas pressure. For any gas, the instrument will show increasing non-linearity for flows above the maximum gas flow value Q_{max}

$$\text{Where :} \quad Q_{max} = \text{Instrument Full Scale} \times \frac{\text{Relative Viscosity of the Gas}}{\text{Relative Density of the Gas}} \times \frac{\text{Standard Pressure}}{\text{Absolute Test Pressure}}$$

The relative viscosity and relative density values are taken from the Gas Properties table below.

Gas Properties

Note: All figures given are based on measurements at 20ºC, 1013mb.

Gas Type	Rel. Viscosity	Rel. Density
Air	1.000	1.000
Ammonia (NH_3)	0.547	0.595
Argon (Ar)	1.224	1.380
Butane-i (C_4H_{10})	0.408	2.064
Butane-n (C_4H_{10})	0.403	2.073
Carbon dioxide (CO_2)	0.808	1.528
Carbon monoxide (CO)	0.960	0.967
Ethane (C_2H_6)	0.506	1.047
Ethylene (C_2H_4)	0.561	0.974
Helium (He)	1.077	0.138
Hydrogen (H_2)	0.485	0.070
Methane (CH_4)	0.605	0.555
Neon (Ne)	1.711	0.696
Nitrogen (N_2)	0.970	0.967
Nitrous Oxide (N_2O)	0.807	1.528
Oxygen (O_2)	1.117	1.106
Propane (C_3H_8)	0.441	1.549
Test Gas G20	0.605	0.555
Test Gas G25	0.656	0.612
Sulphur dioxide (SO_2)	0.691	2.253

CALIBRATION CHECK

General Description

By using a Laminar Flow Element, the FCO732 flow meter is capable of accurately measuring gas flows over an extremely wide range. To achieve the most accurate results the viscosity, temperature, and absolute pressure of the gas must be known as it passes through the Laminar Flow Element.

In the gas industry, obtaining a viscosity value for the gas may be problematic due to the variation in the ratio of its component gasses during the day. One solution would be to use an online gas viscometer, however this is not done in practice as commercial gas viscometers are not widely available and they yield poor accuracy.

Atmospheric pressure can also vary on a daily basis. The FCO732 has an option to be able to measure this, but it does add to the cost of the flow meter.

It is common practice to periodically connect a known master gas jet to a flow meter and adjust either the viscosity value or the instruments gain control to compensate for daily variations in viscosity and atmospheric pressure. This process is time consuming and consequently is normally only performed when operators start to experience a higher number of rejects than normal. At this stage, the adjustment is needed urgently as production has usually stopped and a supervisor is called to perform the adjustment.

The FCO732 simplifies this process allowing the re-alignment of calibration to be safely performed on a routine basis by the operator.

Installation

Master gas jet

At least one master jet is needed. This should be fitted with the same connector as the normal test items to allow for quick and easy connection and precludes the need for a valve in the test line. It may be necessary to hold more than one master jet to accommodate the range of gas types and test pressures used.

If flammable gasses are being used, consideration must be given to the safe disposal of the gas discharged from the master gas jet, as it is not burnt during the calibration check.

Enable the calibration check feature

The calibration check feature is disabled by default to simplify the menus for those not using it. Enable the feature in the Functions menu.

Calibration button

A contact closure on the Control Input connector is required to instigate a calibration check. The connector should be wired to a momentary push button that can be mounted close to the operator (ideally next to the calibrated master gas jets).

Operation

Before using the Calibration check facilities of the FCO732, it must be fully commissioned for the products being tested. Once the stabilisation and delay times, nominal gas viscosity and pressure correction options have been established, a master gas jet can be attached to the system and its calibration value can be learnt.

Learning the calibration

To allow a master gas jet to be used for different pressures and gasses, the flow through the gas jet must be learnt for each product being used.

  ➢ Connect the flow meter to a master gas jet instead of a test item.
  ➢ Set the Learn Cal. option to yes. This is located at the start of the program data menu.
  ➢ Instigate a 'learn calibration' test by pressing the calibration button.
  ➢ Once the learn is complete, use the reset button to reset the flow meter.

The flow reading for the master gas jet must be between 2.5% and 95% of the flow meter's range to be acceptable.

If the calibration learn was successful, the measured flow value is stored as the calibration value in the product data and the product's gain correction is initialised. The multiple product version of the FCO732 has an option to save the gain correction to all products.

If the flow rate for the master gas jet is known and the value stored into the product data does not agree, the stored calibration value can be altered manually. However, the flow meter will only allow calibration checks when the measured flow is within a set tolerance of the learnt flow. If the learnt value is more than a couple of percent from the marked value on the gas jet, it is better to alter the gas viscosity value in the test and repeat the learn process to obtain the correct value.

Once the learn process is completed the Learn Cal. option in the program data menu is automatically turned off.

Calibration Check

Once the calibration value has been learnt, a calibration check can be instigated at any time to re-align the flow meter's calibration to the master gas jet.

  ➢ Connect the flow meter to a master gas jet instead of a test item.
  ➢ Instigate a calibration check by pressing the calibration button.
  ➢ Once the check is complete, use the reset button to reset the flow meter.

If the check was successful, the gain correction factor for the product is modified to ensure the flow meter readings agree with the stored cal flow reading. If the Global Calcheck option is enabled for the enhanced version, the gain correction is applied to all products.

If the check needed to alter the gain by more than a set percentage from nominal, then a calibration fault message is displayed and no gain corrections are made. One possible cause of this is that the wrong gas pressure, gas type or master jet is being used for the check. The default acceptable tolerance is 10% but this may be changed in the Program data menu.

SPECIFICATION

Pressure Ranges

Units \ Range	800mb vacuum	300mb vacuum	200mb vacuum	50mb vacuum	2mb	20mb	50mb	200mb	400mb
mb	800.0	300.0	200.0	50.00	2.000	20.00	50.00	200.0	400.0
bar	0.8000	0.3000	0.2000					0.2000	0.4000
Pa				5000	200.0	2000	5000		
kPa	80.00	30.00	20.00	5.000	0.2000	2.000	5.000	20.00	40.00
mmWC	8154	3059	2039	509.9	20.39	203.9	509.9	2039	4079
inWC	321.2	120.4	80.29	20.07	0.8029	8.029	20.07	80.29	160.6
mmHg	600.0	225.0	150.0	37.50	1.500	15.00	37.50	150.0	300.0
inHg	23.62	8.859	5.906	1.477		0.5906	1.477	5.906	11.81
PSI	11.60	4.351	2.901	0.7252		0.2901	0.7252	2.901	5.802

Units \ Range	1bar	4bar	6bar	8bar	14bar
mb	1000	4000	6000	8000	
bar	1.000	4.000	6.000	8.000	14.00
Pa					
kPa	100.0	400.0	600.0	800.0	1400
mmWC					
inWC	401.5	1606	2409	3212	5621
mmHg	750.1	3000	4500	6000	
inHg	29.53	118.1	177.2	236.2	413.4
PSI	14.50	58.02	87.02	116.0	203.1

Flow Ranges

Units \ Range	2 ml/m	6 ml/m	20 ml/m	200 ml/m	600 ml/m	2 l/m	6 l/m	9.999 l/m	10 l/m	20 l/m
ml/m	2.000	6.000	20.00	200.0	600.0	2000	6000	9999		
cc/m	2.000	6.000	20.00	200.0	600.0	2000	6000	9999		
ml/h	120.0	360.0	1200							
l/s							0.1000	0.1667	0.1667	0.3333
l/m				0.2000	0.6000	2.000	6.000	9.999	10.00	20.00
l/h	0.1200	0.3600	1.200	12.00	36.00	120.0	360.0	599.9	600.0	1200
cf/m							0.2119	0.3531	0.3531	0.7063
cf/h				0.4238	1.271	4.238	12.71	21.19	21.19	42.38
cm/m										
cm/h						0.1200	0.3600	0.5999	0.6000	1.200

Units \ Range	30 l/m	60 l/m	99.99 l/m	100 l/m	200 l/m	600 l/m	2000 l/m	5000 l/m	9999 l/m
ml/m									
cc/m									
ml/h									
l/s	0.5000	1.000	1.667	1.667	3.333	10.00	33.33	83.33	166.7
l/m	30.00	60.00	99.99	100.0	200.0	600.0	2000	5000	9999
l/h	1800	3600	5999	6000					
cf/m	1.059	2.119	3.531	3.531	7.063	21.19	70.63	176.6	353.1
cf/h	63.57	127.1	211.9	211.9	423.8	1271	4238		
cm/m			0.1000	0.1000	0.2000	0.6000	2.000	5.000	9.999
cm/h	1.800	3.600	5.999	6.000	12.00	36.00	120.0	300.0	599.9

Greyed out entries in the tables above are non-standard and only available to special order.

Flow Measurement

Calibration accuracy at 20°C
and at atmospheric pressure .... 10% to 100% range: $< \pm$ (1% of reading +1 digit).
0 to 10% range: $< \pm$ (0.1% range +1 digit).

Temperature Coefficients
Zero: .... Automatic zero facility, or if autozero is not used
x1 range: $< 0.05\%$ range per °C.

Span: .... $< 0.1\%$ per °C.
Long term drift (span) .... $< 1\%$ per year.

Pressure Measurement

Calibration accuracy at 20°C .... 10% to 100% range: $< \pm$ (1% of reading +1 digit).
0 to 10% range: $< \pm$ (0.1% range +1 digit).

Temperature Coefficients
Zero: .... $< 0.05\%$ range per °C. Semi-automatic zero control.
Span: .... $< 0.1\%$ per °C.
Long term drift: .... $< 1\%$ per year.

Pneumatic

Media Compatibility .... Clean dry air or non hazardous gas.
LFE Operating Pressure .... 4bar maximum.
Gas Temperature at LFE .... 0-50°C.
Air Supply Pressure .... Maximum 10 bar gauge, Minimum 5 bar gauge.
Regulator Supply Pressure .... Maximum 16 bar gauge, Minimum regulator range
+ 1bar.
Pneumatic Connections
Air supply: .... 6mm push-in tube connector.
Regulator supply and output .... 8mm push-in tube connector.
Programmable outputs .... 4mm push-in tube connector.
Pressure sense port .... 4mm push-on tube connector.
Laminar Flow Element ports .... dependent on range, see dimensions below.

Electrical

Supply Voltage .... 24V DC $\pm$ 10% at $< 0.5A$
Inputs .... Opto coupled, 5V to 24V DC into 10kΩ.
Can be wired active high or low.
Outputs .... Transistor outputs (active high)
12VDC - 45VDC, 120mA.
Program Data Retention .... > 10 Years in non-volatile memory.

Physical

Enclosure .... Steel construction with paint finish.
Dimensions* – Bench Case .... 232mm x 147mm x 296mm (WxHxD).
Dimensions* – Rack Case .... 267mm x 133mm x 296mm (WxHxD).
Weight* .... 5 kg ±0.5 kg
Temperature Limits .... 0-70°C storage, 10-40°C working.

*Excludes LFE

Instrument Options

Analogue Output ....0-5V or 0-10V for flow and pressure.

Atmospheric pressure sensor ....Allows automatic correction of flow reading for changes in atmospheric pressure.

Enhanced Firmware ....50 products, simple sequence, supports extra inputs and outputs, supports LAN.

Enhanced I/O ....BCD inputs for product selection. Extra programmable outputs. Only available with enhanced firmware.

LAN ....Ethernet port for local area network connection. Only available with enhanced firmware.

RS485 communications port....................Electrically isolated, suitable for multi-drop communications.

Real-Time-Clock....................................To allows printed results to include time/date.

Pneumatic pilots.....................................Two programmable ports for jig control etc.

Rack-mounting kit ....Suitable for Half 19" x 3U rack housing.

DIMENSIONS

Main unit Desktop Mounted:

Excluding rear mounted LFE.
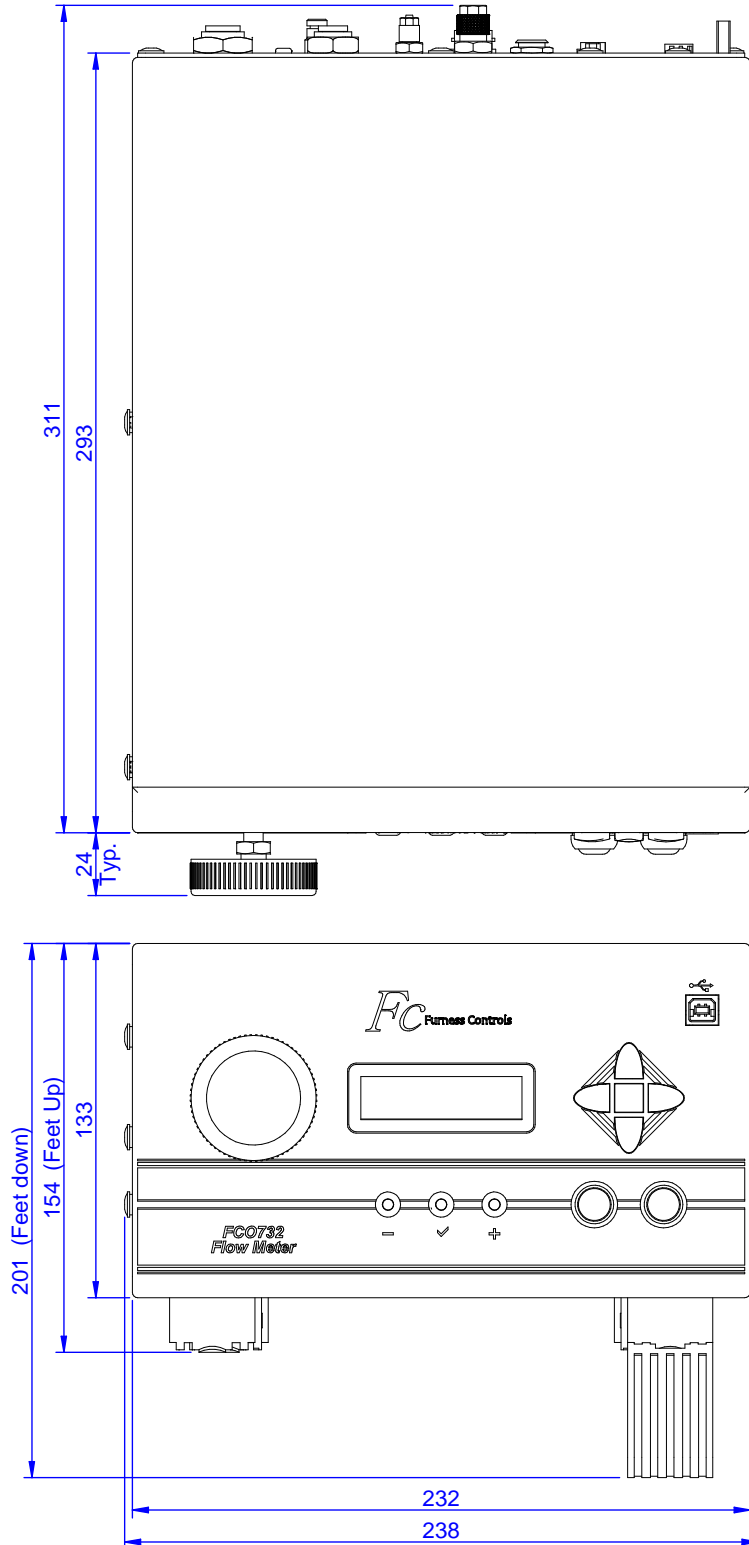
Main Unit Rack Mounted:

Excluding rear mounted LFE.
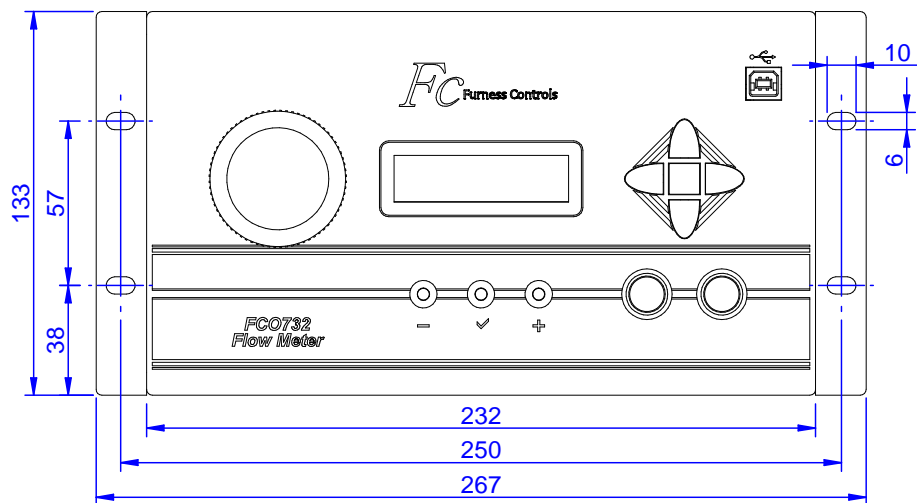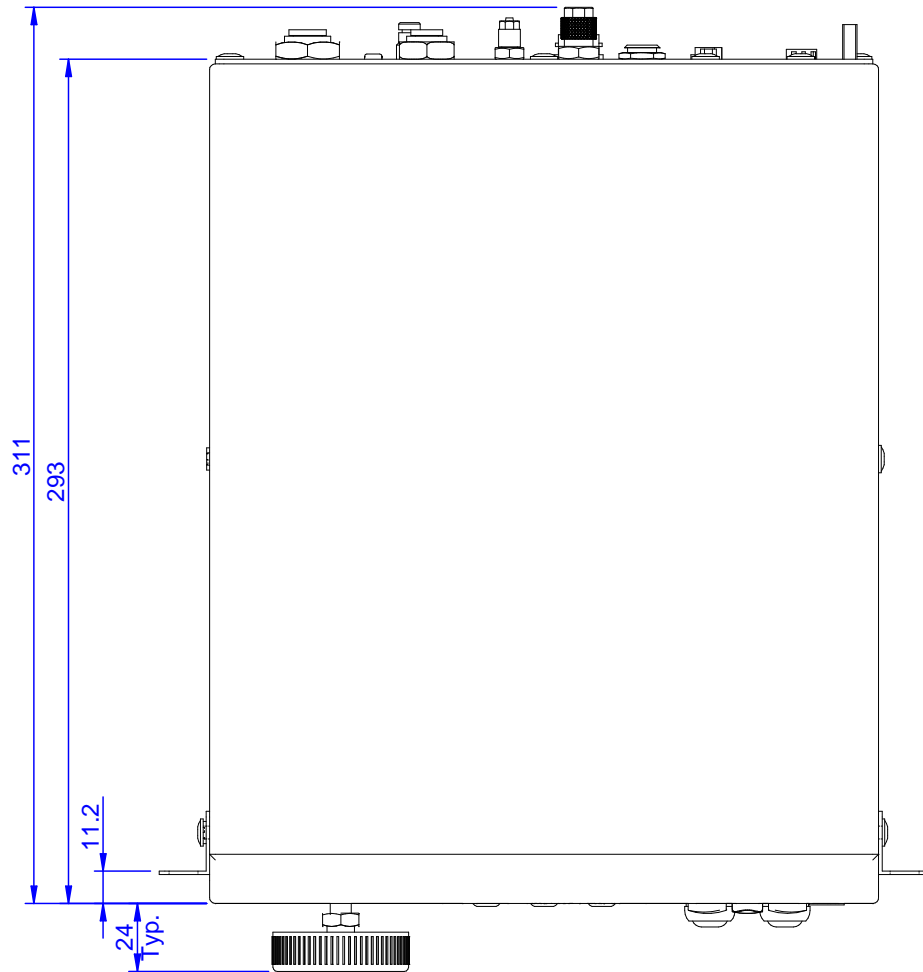
Flow elements (20cc, 200cc, 600cc):

209 Max.
170.4
152.4
101.6
Flow direction
- +1 +2
88.9
2-Off M4 mounting holes
6mm O.D Tube
4mm O.D for FCO96-2cc
45 Max.
25.4
7.6
15.9
15.9
20.3
D.P connections for 4mm (A1) or 6mm (A2) O.D tube
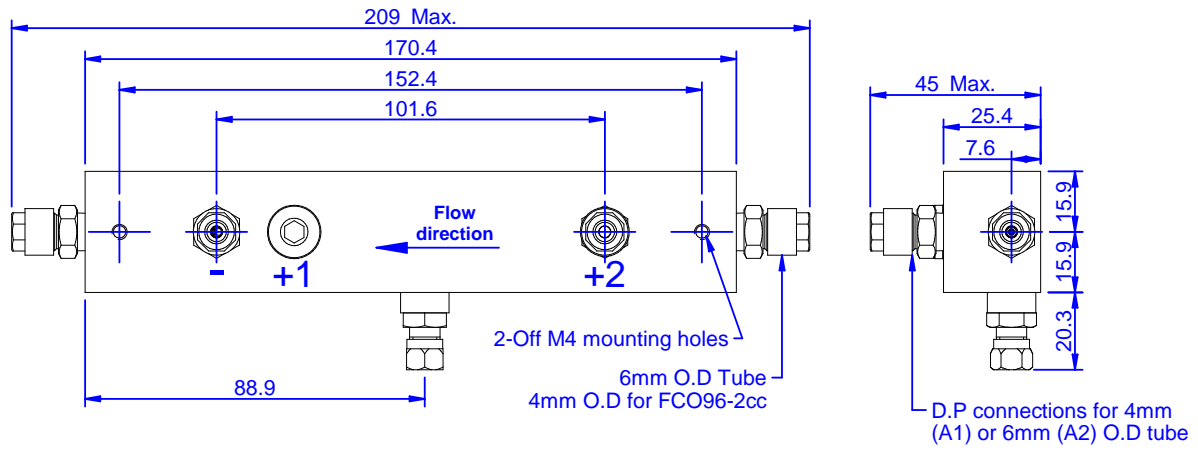
Flow elements (2L, 6L, 10L, 20L):

424.5
317.5
177.8
101.6
44.4
31.8
- +1 Flow direction +2
19.0
4-Off M4 mounting holes
D.P connections for 4mm (A1) or 6mm (A2) O.D tube
49.4 Max.
30.2
9.5
Ø 12
22.2
22.2
14.9

Flow elements (30L):

424.5
317.5
177.8
101.6
44.4
31.8
- +1 Flow direction +2
19.0
4-Off M4 mounting holes
D.P connections for 4mm (A1) or 6mm (A2) O.D tube
63.6 Max.
44.4
23.9
Ø 12
22.2
22.2
14.9
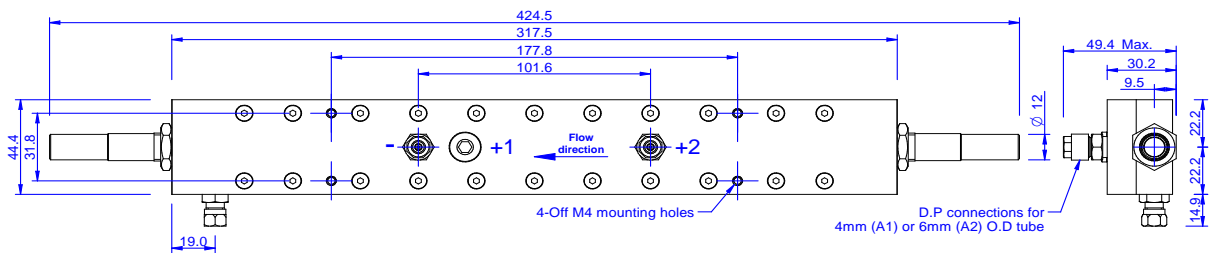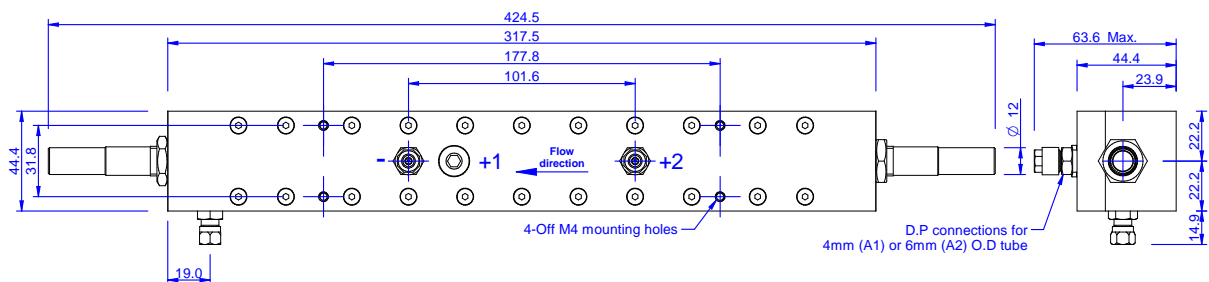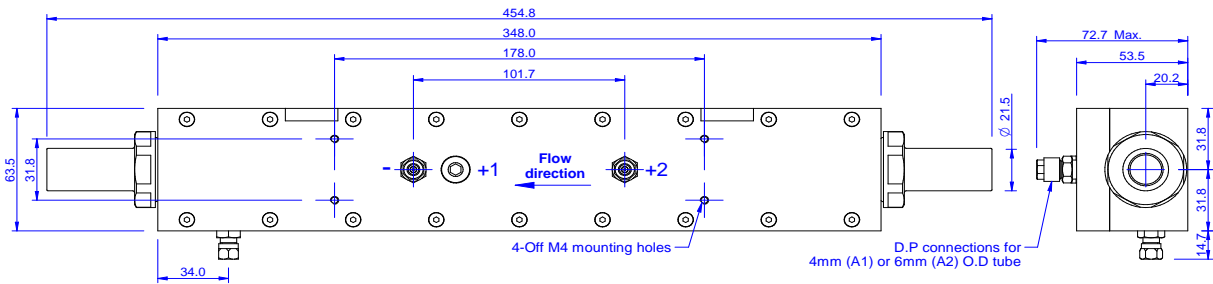
Flow elements (100L):

Flow elements (200L):
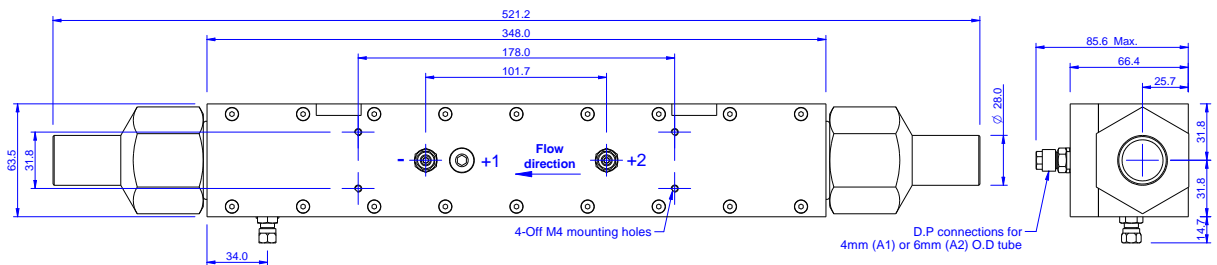
Flow elements (2000L, 5000L):

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