Sentronics FD-010-01

FlowSonic Controller Module

Installation and User Guide

Sentronics has a policy of continuous product improvement, specifications are subject to change without notice.

Definitions

The following terms are used throughout this document:

WARNING Identifies actions or conditions which may result in a risk of bodily injury or death

CAUTION Identifies actions or conditions which may result in damage to the product or other equipment to which it is connected, or which may cause data to be invalid, inaccurate, or permanently lost

Meter Refers to the FlowSonic ultrasonic flow sensor

FCM is an abbreviation of FlowSonic Controller Module

Warranty

Sentronics warrants that the FCM will be free from defects in materials and workmanship, and shall perform substantially in accordance with published specifications, for a period of one (1) year from the date of sale.

This warranty applies solely to the original purchaser of the unit from Sentronics or its authorised distributors, and is not transferable.

This warranty does not cover damage from neglect, mechanical abuse, modification (including firmware modification), use outside published specifications, accidents, or normal wear and tear on mechanical components.

To obtain warranty service under this agreement, contact Sentronics with the model and serial number of the unit, the date of purchase, and a detailed description of the fault.

Sentronics shall, at its own option, repair or replace the unit as necessary to bring it back into specification.

UNDER NO CIRCUMSTANCES SHALL SENTRONICS LIMITED BE RESPONSIBLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL LOSSES OR DAMAGES RESULTING FROM ANY FAILURE OF THE FCM (INCLUDING ANY METER TO WHICH IT IS ATTACHED) TO PERFORM IN ACCORDANCE WITH SPECIFICATIONS.

Safety Information

WARNING: The Meter is designed for use with petroleum spirit and other highly flammable liquids. To avoid risk of personal injury, read and follow all safety instructions before installing or using. The FCM is designed to be installed and used in a safe area which is well away and protected from any flammable liquids or fumes.

Regulatory Compliance (EU)

The FCM complies with:

EN61010:2010 (Safety requirements for electrical equipment for measurement, control, and laboratory use. General requirements)

EN61326-1:2013 (Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements)

WEEE Compliance (EU)

Do not dispose of this product as unsorted domestic waste. Contact Sentronics for recycling information when it reaches the end of its useful life.

Explanation of Symbols

The following symbols may appear on the FCM and/or ancillary equipment:

Symbol	Meaning
	This equipment is designed to operate from an AC power supply
	Read this manual before using the product
	This terminal is a protective earth
	**WARNING** Risk of electric shock, mains voltage present
	**WARNING** Consult this manual for details of safety procedures which must be followed when working inside this equipment

WARNINGS

The following conditions apply to the installation and use of this product. Read and follow all safety warnings before installing or using the FCM.

Important: additional warnings apply to the Meter. Read the installation guide for the Meter in conjunction with this manual and ensure all warnings relating to the safe installation and use of the Meter are followed.

The FCM must be installed by persons who are properly trained and familiar with the safe installation of electrical equipment in an automotive R&D environment.

The FCM's environment must be maintained within its specified limitations at all times. If installed in a rack with other equipment, ensure sufficient cooling air flow is provided. Ensure the FCM does not block necessary cooling vents in other equipment located above or below it in the rack.

Ensure the FCM is installed in a suitable location where it is protected from dust and liquids. Under no circumstances should the FCM be exposed to flammable liquids or vapour.

Switch off mains power to the FCM before connecting or disconnecting data or signal cables. The power switch on the front panel may be used for this purpose.

Any electrical connections to the Meter must be made using only the correct electrical connector specified by Sentronics. Wiring must be rated for the full operating temperature range of the Meter and should be resistant to any liquids used with the Meter.

This equipment must be earthed.

The body of the Meter must be securely grounded using the earthing points provided (see illustration below).

<insert illustration of earthing points>

The FCM is designed to be powered from a single phase mains supply, which should be protected using a suitable current limiting device and GFCI.

The mains plug on the detachable supply cord acts as the mains disconnect device for this equipment. This plug must be installed near the equipment and must remain easily accessible when the equipment is installed.

The FCM incorporates a T2A (anti-surge) fuse. Should the fuse require replacement, replace it only with a fuse of the same type and rating.

The FCM is not designed to be installed or used in a vehicle.

The FCM provides electrical isolation between certain data and signal cables. This isolation is for functional purposes only and is not a safety barrier. Connect only SELV circuits to the ports on the back of the FCM.

Hazardous voltages exist within the FCM when energised. Always disconnect power from the FCM by removing the mains power cable from the IEC inlet before removing any cover.

The case of the FCM must only be opened by suitably trained and qualified persons.

The FCM provides electrical separation between its local earth connection and the Meter. The Meter must therefore be earthed separately using the earthing points provided.

The FCM does include links which can be set by the installer. Disconnect power from the FCM before opening the lid, and do not attempt to operate the unit with the lid removed. Besides the links described in this manual, there are no user serviceable parts inside.

CAUTIONS

Exceeding the functional temperature and pressure specifications for the Meter may cause inaccurate readings, including permanent errors which remain even after the excessive temperature or pressure is reduced. Any damage caused in such a manner is not covered under the Warranty.

Contacting Sentronics

Sentronics may be contacted via any of the following:
Post: Sentronics Ltd, Unit 34 Downton Business Centre, Downton, Salisbury SP5 3HU
Tel: +44 1725 513703
Fax +44 1725 513399
Email support@sentronics.com
Web www.sentronics.com

Returning Equipment to Sentronics

Prior to returning the Meter to Sentronics for any reason, it must be emptied, cleaned, and decontaminated. This process is required if any part of the Meter has been in contact with any fluid other than clean water.

Note: All regulations relating to the transportation of hazardous materials must be followed. Sentronics accepts no responsibility for any loss or damage caused by flammable or other hazardous liquids which may remain within the Meter during shipment.

FCC COMPLIANCE INFORMATION STATEMENT

SUPPLIERS DECLARATION OF CONFORMITY

Manufacturer:	Sentronics Ltd
Responsible Party in the USA:	eda@sentronics.com +1 617 325 1678
Product:	FD-010-01 FlowSonic Controller Module with DP-010-02 FlowSonic LF
Authorisation Procedure:	Suppliers Declaration of Conformity (SDoC)

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

We, Sentronics Ltd, have determined that the above named equipment has been shown to comply with the applicable technical standards. Furthermore, we warrant that each unit of equipment marketed is identical to the unit tested and found acceptable with the standards. The records maintained continue to reflect the equipment being produced within the variation that can be expected due to quantity production and testing on a statistical basis.

Issued by:

Sentronics Ltd
Unit 34
Downton Business Centre
Downton
Salisbury
SP5 3HU
UK

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Managing Director, Sentronics Ltd

Introduction

The FCM is designed to be used in conjunction with the FlowSonic fuel flow meter. FCM adds the following capabilities, to create a seamlessly integrated flow measurement system that can integrate easily with your existing data logging and monitoring equipment.

- Real-time display of flow rate, temperature and other useful information
- Capability to integrate a separate density meter, to produce true mass flow data in real time
- CAN bus interface with isolation, user selectable bit rate and optional termination
- TTL pulse output with isolation and enhanced drive capability
- 0-10V isolated voltage output
- 4-20mA isolated current loop, with source and sink capability for ease of installation
- Digital input to reset and/or activate totalisers

Features of the FCM

<insert annotated photo front view>

1. Mains power switch
2. LCD display
3. RESET button
4. DISPLAY button
5. UP button
6. DOWN button
7. OK button

<insert annotated photo rear view>

1. IEC inlet (mains connector)
2. Fuse holder
3. Protective earth stud
4. Flow sensor connector
5. RS232 port for density meter
6. USB 2.0 B connector
7. CAN bus connector
8. 4-20mA interface connector
9. Totaliser enable / reset connector
10. TTL pulse output connector
11. 0-10V analogue voltage output connector

Setting up the FCM

You will need:

- The FCM unit itself
- A FlowSonic flow meter

- An interconnection cable to link the two
- Suitable cables to link the FCM to any other monitoring, control or logging equipment you may have
- Mains power

Quick set-up process

- Switch off FCM.
- Connect FlowSonic to FCM.
- (If applicable) connect density meter to FCM.
- Connect FCM to any logging / monitoring equipment.
- Ensure that FCM and FlowSonic each have good earth connections.
- Switch on FCM.
- Press and hold the [RESET] key for three seconds. The FCM automatically detects the FlowSonic and configures itself.
- Use the front panel to make other changes to the configuration of the FCM as necessary.

Detailed set-up process

CAUTION: Disconnect power from the FCM before making or breaking any other electrical connections to it.

Connect the FlowSonic to the FCM using a cable of suitable length. Sentronics recommends using one of the following:

Part number	**Type**
??????	FCM to FlowSonic cable 5m
??????	FCM to FlowSonic cable 10m
??????	FCM to FlowSonic cable 20m

Ensure that the FCM is well outside any area in which flammable liquids or vapours may be present. The FCM is not a hazardous area product.

The FCM provides functional isolation from the Meter, which is commonly required in electrically noisy environments to improve reliability. It also prevents large currents from flowing in grounding and earthing leads, in the event that the earth potential is not the same at the Meter and the FCM.

WARNING: The Meter and the FCM must each be individually provided with a suitable, reliable earth connection.

An earthing stud is provided on the back panel of the FCM for this purpose. Make a secure protective earth connection between this stud and the rack in which the FCM is mounted, and ensure there is good electrical continuity between the stud and earth.

Connecting to a density meter

The FCM is capable of accepting real time fluid density information from a separate 3rd party density meter. The port on the FCM is compatible with density meters that use an EIA-232D (RS-232) interface.

Make the following connections to the FCM:

FCM pin	Meaning	Function
TxD	Transmitted data	Serial data from the FCM to the density meter
RxD	Receive data	Serial data from the density meter to the FCM
GND	Ground	Ground connection to the density meter

Note: consult the manual for the density meter to determine the direction of its serial data signals. If the FCM does not appear to recognise the density meter, it may be that TxD and RxD have been connected incorrectly.

Fit a suitable D-type connector to the end of the cable on the density meter, and plug it into the port on the back of the FCM. The connector pin-out is shown in Appendix A.

The serial data rate and format must be set on the FCM to match the settings on the density meter. The factory default is 9600 baud, 8 data bits, no parity, 1 stop bit.

Details of the data format required by the FCM are given in Appendix C.

The density meter port on the FCM is electrically isolated from the local earth, but instead shares a common earth with the FlowSonic. This is because it is expected that the density meter and FlowSonic will be located in close proximity to each other in normal use, and that the density meter will receive power from a supply which is near itself rather than necessarily being close to the FCM.

Connecting to a PC via USB:

The FCM can be configured, calibrated and controlled from a PC via its USB interface. Connect the FCM to the PC using a standard USB 2.0 A-B cable. Ensure the cable conforms to USB standards.

Extension cables are not permitted by USB standards. If a length of > 5m is required, use a cable with an active repeater.

The USB interface is not isolated from the local earth. If isolation is required, then this must be provided externally.

The FCM appears to the host PC as a virtual COM port. Standard serial terminal software may be used to communicate with the FCM.

The port settings for the virtual COM port are: 115200 baud, 8 data bits, no parity, 1 stop bit. These settings cannot be changed on the FCM.

Connecting to a CAN bus:

The FCM provides a fully isolated CAN bus interface with optional termination.

The FCM can be set to operate at any one of a range of different bit rates. and the number of messages/sec which it transmits onto the bus can be configured.

Three termination options are provided:

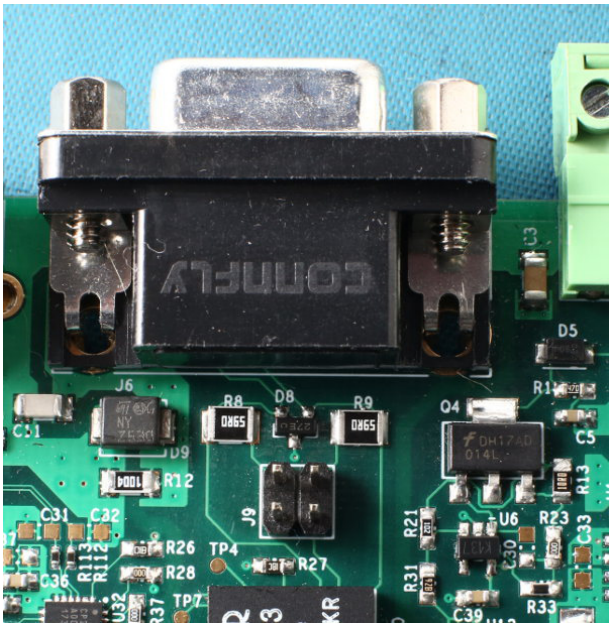
- No termination
- Split termination
- Parallel termination

The CAN bus should be wired as a single twisted pair with termination at both ends (and nowhere else). The lengths of any stubs must be kept to an absolute minimum.

Changing the termination option requires removal of the lid of the FCM as follows.

WARNING: Hazardous voltages exist inside the FCM. Disconnect mains power before opening the case.

1. Disconnect the mains power cable from the IEC inlet.
2. Remove the <NNNN> screws which hold the lid in place.
3. Remove the lid to reveal the main PCB.
4. The CAN termination links are marked J9 and are located right behind the CAN connector as shown:



5. Two shorting links may be fitted to select the type of termination required as follows. If termination is not required, then it it is recommended to store the links safely for future use by placing each one onto a single pin. “Split termination” is provided as an option, which may offer improved EMC performance in case the FCM is used in an electrically noisy environment.

Position	Termination
Left-right	120R across CANH and CANL
Top-bottom	Split termination: 60R from CANH to +2V5 60R from CANL to +2V5
No links (factory default)	None, unterminated

6. Replace the lid and tighten all screws.
7. The FCM may now be powered on.

Connecting to a 4-20mA current loop

The FCM can connect to a 4-20mA current loop receiver. The relationship between flow rate and current can be programmed, and the FCM can unambiguously indicate fault or error conditions by passing a current which is outside of the normal range.

The FCM can be configured either as a current source or a current sink, depending on the requirements of the device to which it is connected. Configuration is performed by connecting to different screw terminals.

The 4-20mA port on the FCM has three terminals as follows:

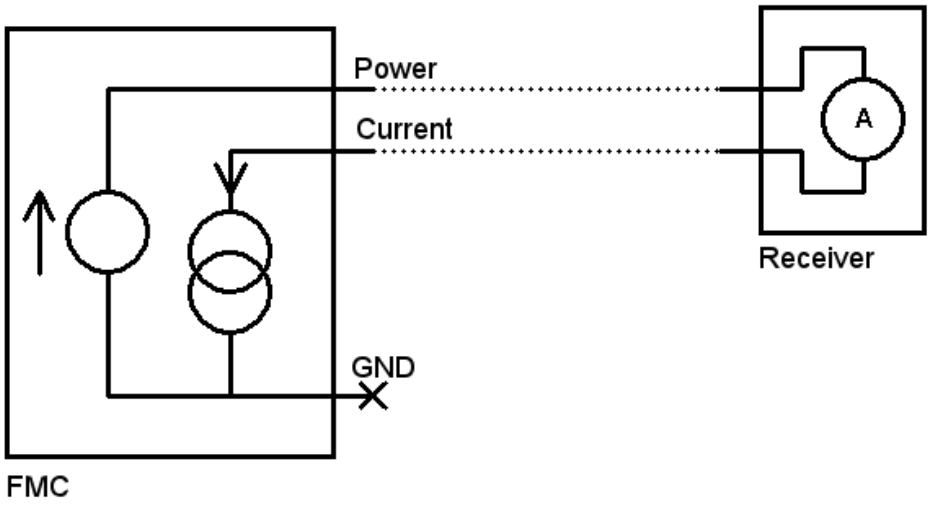
FCM pin	Meaning	Function
Power	Power supply	Positive voltage source provided by the FCM's power supply
Current	4-20mA sink	Sinks variable current to GND depending on flow rate
GND	Ground	Ground connection

Normally only two of these three terminals are used.

<u>Powering the loop from the FCM</u>
The FCM contains a +12V (nominal) power supply which can be used to provide the loop current. In this mode, the FCM powers the loop and sources current.

Connect the receiver between the power output and the current sink terminal as shown. The GND terminal on the FCM is not used.

CAUTION: Do not use the power output on the 4-20mA connector for any other purpose. The internal power supply is current limited.

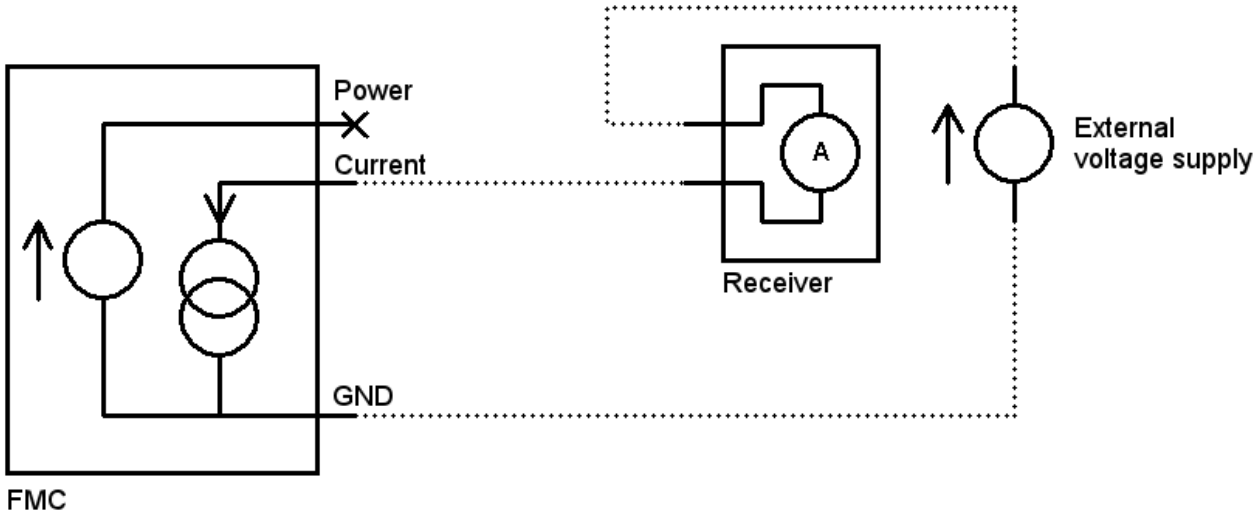


Powering the loop externally

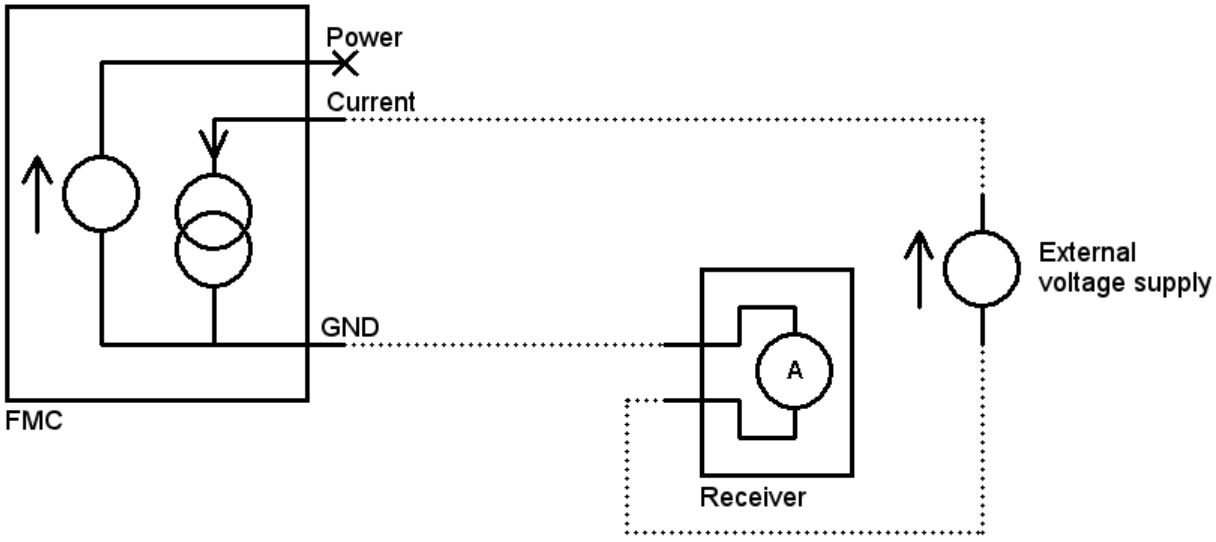
If an external power supply is to be used, connect the FCM as follows. In this configuration the power output from the FCM is not used and should be left unconnected.

Two alternative connection methods are possible.

1) FCM as current sink. In this mode, current flows from the external supply into the receiver, out of the receiver into the Current terminal of the FCM, then out from the GND terminal of the FCM back to the supply.



2) FCM as current source. In this mode, current flows from the external supply into the Current terminal of the FCM, out from the GND terminal of the FCM into the receiver, and finally out from the receiver back to the power supply.



Connecting to an analogue voltage input

The FCM can connect to an analogue voltage input on a data logger, multimeter, engine ECU or similar type of device. The possible range of voltages is 0 to +10V, and the range of voltages actually used can be limited to a sub-set of this range (eg. 0 to +5V).

The relationship between flow rate and voltage can be programmed, and the FCM can unambiguously indicate fault or error conditions by generating a voltage which is outside of the normal range.

The voltage output is designed to drive high impedance inputs only. It is fully isolated, ie. does not share a common ground with any other circuit.

Connect the outer shield of the BNC connector to ground at the receiver, and the central pin to an analogue voltage input.

Connecting to a TTL pulse input

The FCM can generate a series of square digital pulses which vary in width according to the flow rate. Each individual pulse corresponds to a fixed amount of liquid passing through the flow meter. The number of pulses per unit of liquid can be programmed.

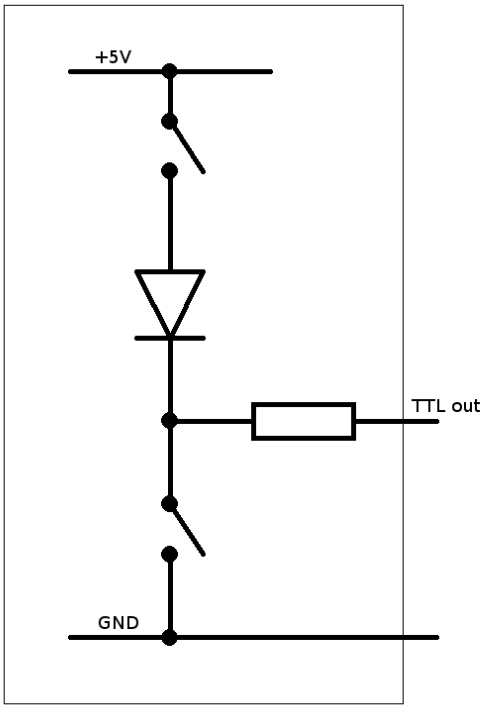
This output is suitable for use with logging and display equipment that is designed to interface with turbine meters, or other meters which measure flow based on a positive displacement method.

The TTL output on the FCM shares a common ground with the external logic input. Together, these two ports are isolated from all other circuits.

The nominal amplitude of pulses on the TTL output is 0 to +5V.

If a higher voltage is required, it is permissible to pull the TTL output up to a higher voltage (up to +24V) using an external pull-up resistor.

The simplified equivalent circuit of the TTL output is as shown:



Connecting to an external logic output

The FCM has a built in totaliser which integrates the measured flow rate over time to give a value for the total amount of liquid which has passed through the flow sensor.

This totaliser can be controlled by a logic signal, allowing it to be started, stopped and reset by an external device.

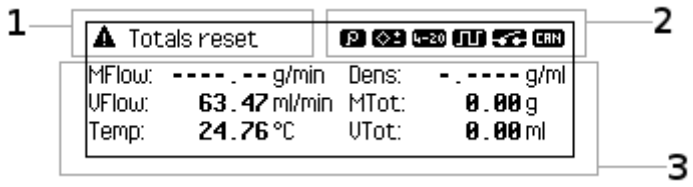
The external logic input on the FCM shares a common ground with the TTL output. Together, these two ports are isolated from all other circuits.

The logic input is internally pulled up to +5V via a 4k resistor. To assert the logic input, connect it to the logic GND terminal using a switch, relay or transistor. Alternatively, it may be connected directly to a digital output on an external device with digital I/O capability.

The logic input may be driven up to +12V (measured with respect to the logic GND terminal) without damage.

Setting up the FCM using the front panel controls

Introduction to the display

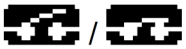


The display is divided into three areas as shown:

1) Notification area
This area shows warning messages and other notifications. These normally indicate that something has happened (such as a communication error or other electrical fault) which means normal flow measurement has been interrupted.

If there are multiple issues requiring attention, then these are displayed one at a time in sequence. If there are no issues at all, which should normally be the case, then this part of the display is empty.

2) Icons
This area shows icons which indicate that various inputs or outputs are currently active:

Icon	Meaning
	External density meter is in use
	Analogue voltage output is enabled
	4-20mA current loop output is enabled
	TTL pulse output is enabled
	External logic input is asserted *
	CAN bus interface is enabled

* The icon which is displayed for the external logic input depends on how the input is configured. See the section entitled “Configuring the Totaliser” for more details.

3) Measurement area
This area shows the current values of various measured quantities.

Press the [DISPLAY] button to cycle between various screens of information. Each screen shows one or more of the measured quantities listed under the heading “Displayed quantities” below.

Some screens show just a single quantity in a large font, designed to be easily read from some distance away. Others show several quantities on screen together.

Introduction to the front panel controls

The buttons on the front panel of the FCM are as follows:

Button	Function
RESET	Resets the value of the totaliser to zero Press and hold for three seconds to auto-configure the FCM to match the settings on the FlowSonic.
DISPLAY	Each press of this button cycles between different screens of information. When navigating the configuration menus, pressing this button exits back to the information display screen without making any changes.
UP	At the information display screen, opens the configuration menus. When navigating menus, moves the highlight bar up, or increases a highlighted value.
DOWN	At the information display screen, opens the configuration menus. When navigating menus, moves the highlight bar down, or decreases a highlighted value.
OK	When navigating menus, selects the highlighted option, or confirms entry of a value.

Pressing and holding [UP] or [DOWN] changes settings rapidly.

Displayed quantities

The following measured quantities can be displayed:

Label	Quantity	Unit
MFlow	Current mass flow rate	g/min
VFlow	Current volumetric flow rate	ml/min
Temp	Fluid temperature	°C
Dens	Fluid density	g/ml
MTot	Total accumulated mass	g *
VTot	Total accumulated volume	ml *
DMDens	Fluid density as reported by density meter	g/ml
FSDens	Fluid density as reported by FlowSonic	g/ml
ΔDens	Difference between density values reported by density meter vs FlowSonic	g/ml
DMTmp	Fluid temperature as reported by density meter	°C
FSTmp	Fluid temperature as reported by FlowSonic	°C

ΔTmp	Difference between temperatures reported by density meter vs FlowSonic	°C

* the units used for the accumulated values will change from g to kg, and from ml to l, if necessary to fit the totals on screen.

If, for whatever reason, a particular value cannot be measured, then a series of dashes are shown in place of the measured value. For example, if the FCM is configured to use an external density meter, but that meter is switched off, then both MFlow and Dens will show dashes instead of numbers.

Additional measured quantities and status information are available via menus, and are described below in the sections to which they are relevant.

Notifications and Warnings

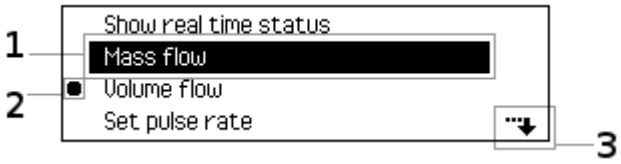
The following notifications may be shown:

Notification	**Meaning / corrective action**
TTL output overload	The TTL output is shorted, or has been connected to an unsuitable electrical load. Check the connection between the TTL output and the input of the data logging system.
No flow sensor	No flow data is being received from the FlowSonic. Ensure it is connected correctly, and that the settings in the FCM match those on the FlowSonic Meter itself.
CAN data lost	Data transmitted onto the local CAN bus was not acknowledged and has been lost. Check that the CAN bus is connected, that the configured bit rate matches that of the other devices on the bus, and that there is enough free bandwidth available for the FCM to transmit.
FS serial comm error	A communication error has occurred between the FCM and the FlowSonic. Check the connection between the two.
Reconfigured OK	The FCM has been automatically reconfigured to match the settings in the FlowSonic.
Totals reset	The totalisers have been reset.
Factory reset	The configuration ot the FCM has been reset back to the factory default state.
No density meter	The FCM is configured to use an external density meter, but no valid data is being received via the RS232 port. Check that the density meter is plugged in and switched on, and that its RS232 settings match those on the FCM.
Density RS232 err	Corrupted RS232 data has been received from the density meter. Check that the RS232 settings on the density meter match those on the FCM.

Menus

The FCM may be configured using a set of on-screen menus.

Press [UP] or [DOWN] at the information display screen to open the menu tree. The currently selected option is highlighted, and the highlight may be moved using the [UP] and [DOWN] buttons to select an option. Press [OK] to confirm a selection.



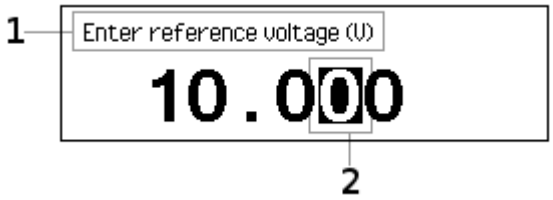
1) This is the highlighted option, which can be selected by pressing [OK].

2) This icon may appear to indicate that a particular setting is currently active.

3) This icon indicates that there are further menu options below, which can be accessed by pressing [DOWN]. A similar icon appears in the upper right corner of the display if there are additional options above those currently shown, which can be accessed by pressing [UP].

At any time, you may exit the currently displayed menu without making any changes to settings by pressing [DISPLAY].

Entering values



1) This prompt acts as a reminder showing which value is being changed.

2) The currently selected digit is highlighted by being displayed in white-on-black.

Numerical values are entered a digit at a time using the [UP], [DOWN] and [OK] buttons. When changing a value, the existing value is displayed with the first digit highlighted. Press [UP] or [DOWN] to change the value of that digit, then [OK] to confirm the digit and move the highlight one place to the right.

Most values have inherent upper or lower limits. If pressing [UP] or [DOWN] does not change the value of the highlighted digit, it is likely because changing the digit would result in a value which is out of range. For example, the analogue output cannot generate a

voltage exceeding 10V, so it is impossible to set its upper limit to a value greater than 10.000.

After entering the last digit, the FCM shows 'OK' in the lower right corner of the LCD. Press [OK] to confirm the new value.

At any time prior to the final confirmation, you may also press [DISPLAY] or [RESET] to abandon entering a new value, leaving it unchanged.

Top level menu

The top level options are as follows:

Menu option	**Function**
Totaliser	Configure the totaliser and its logic input
TTL output	Configure the TTL pulse output
Voltage output	Configure the 0-10V analogue voltage output
4-20mA output	Configure the 4-20mA current loop output
CAN bus	Configure the CAN bus interface
Density meter	Configure the external density meter
Flow sensor	Configure the FCM to match the settings on the FlowSonic
Display	Configure the LCD display on the FCM
System info	Show various pieces of information about the FCM

Configuring the Totaliser

The totaliser records the total accumulated mass and volume of fluid which has passed through the Meter since the totaliser was last reset.

The totaliser value is stored in non-volatile memory, so its value is retained even if the power to the FCM is switched off.

Regardless of how the totaliser is configured, it may be reset to zero by pressing the [RESET] button, via the USB interface, or using the dedicated external logic input.

To open the Totaliser menu, open the main menu and select “Totaliser”.

The totaliser has four operating modes, which govern the interpretation of the external logic input as follows:

Menu option	Function
Count always / switch ignored	The totaliser runs continuously. The logic input is ignored.
Count always / switch input resets	The totaliser runs continuously. When the logic input is asserted, the totaliser is reset to zero, and remains at zero until the logic input is de-asserted.
Count while active / reset	The totaliser runs only while the logic input is asserted. When the logic input is de-asserted, the totaliser value is frozen. When the logic input is next asserted, the totaliser value is reset and begins counting up from zero.
Count while active / no reset	The totaliser runs only while the logic input is asserted. When the logic input is de-asserted, the totaliser value is frozen. When the logic input is next asserted, the totaliser value resumes counting from its previous value and is not reset.

By default, the logic input is “asserted” when the input is connected to ground. This can be changed as follows:

- Open the Totaliser menu
- Select “Configure sense of switch input”

This opens a menu as follows:

Menu option	Function
Active when closed	The logic input is deemed “asserted” when the logic input is connected to GND.
Active when open	The logic input is deemed “asserted” when the logic input is at a high level, ie. not connected to GND.

An icon is displayed in the upper right corner of the screen any time the logic input is asserted. The icon changes depending on the sense of the input:

Icon	Meaning
	External logic input is low (switch is closed)
	External logic input is high (switch is open)

Configuring the TTL output

The TTL output generates square logic pulses at a rate which depends on the measured flow rate.

It can generate pulses at a rate governed by either the mass flow or the volume flow, or it can be disabled. It is disabled by default.

The FCM incorporates a smoothing filter which can be used to stabilise the rate at which the TTL output responds to changes in flow rate.

Without the filter, the rate at which pulses are generated will vary as the flow rate through the Meter varies, which is useful in order to reveal details of how the flow varies with time. With the filter enabled, the TTL interface responds more slowly to changes in flow rate, which may be useful when calibrating the response of the Meter and FCM under steady-state conditions.

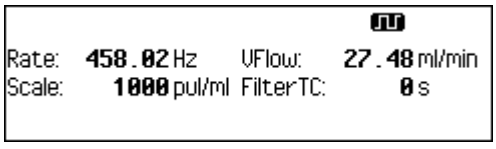
To open the TTL interface menu, open the main menu and select “TTL output”.

The TTL output menu

Menu option	**Function**
Show real time status	Displays various useful pieces of information about how the TTL interface is configured, and what it is doing, in real time
Mass flow	The TTL output indicates the mass flow rate
Volume flow	The TTL output indicates the volume flow rate
Set pulse rate	Sets the number of pulses per g (mass flow) or per ml (vol flow)
Set filter time constant	Sets the time constant of the smoothing filter
Disable TTL output	Disables the TTL output

Real time status
This screen shows how the TTL interface is configured and what it is doing.

Example:



The values displayed are:

Label	Quantity	Unit
Rate	Number of pulses/sec being generated on the TTL interface	Hz
VFlow	Current volume flow rate	ml/min
Scale	Programmed number of pulses per ml	pulses/ml
FilterTC	Smoothing filter time constant	seconds

In this example:

- The TTL interface is configured to output volume flow
- The programmed rate is 1000 pulses per ml
- The smoothing filter is disabled (Filter time constant equals zero)
- The instantaneous volume flow rate being measured by the Meter is 27.48 ml/min

27.48 ml per minute = 0.458 ml per second
Scale 1000 pulses per ml
Therefore, pulse rate = 1000 * 0.458 = 458 Hz

Note: there may be slight differences between the displayed values and those which may be calculated by hand, as a result of the limited resolution of the display. The FCM operates to a much higher degree of numerical precision internally than can be shown.

If the TTL output is configured to output mass flow, then the values and units which are shown on this screen are modified accordingly.

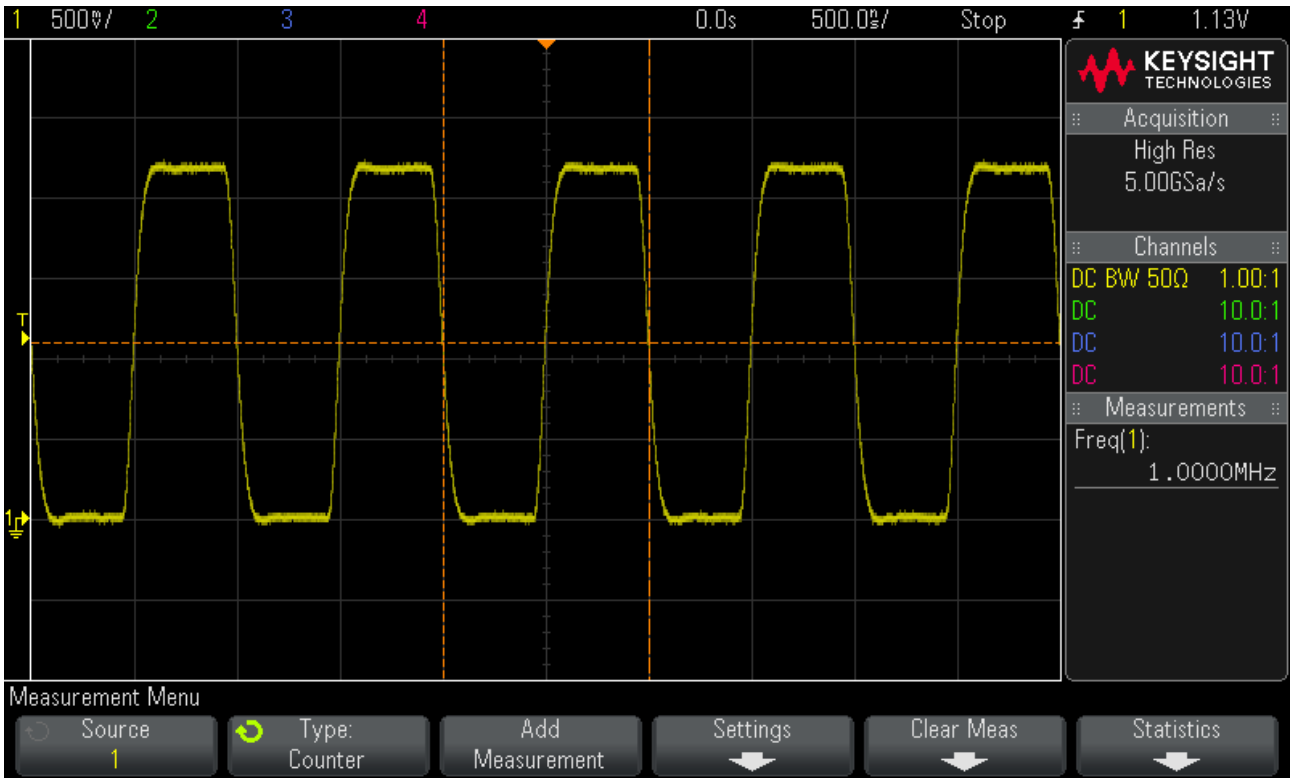
If the smoothing filter is enabled, and the flow rate is not absolutely constant, then the 'Rate' value may not match the instantaneous flow rate. This is because the 'Rate' value reflects the action of the smoothing filter, and therefore it will lag behind changes in flow rate.

Press the [DISPLAY] key to exit this screen and return to the normal information display.

Recommendations

- The maximum TTL pulse frequency should not exceed 1 MHz
- If the cable between the FCM and the receiving device is > 5 metres long, use a 50 Ohm coaxial cable and terminate the receiver input with 50 Ohms

The signal from the FCM at 1 MHz into 50 Ohms should appear as per the example below:



Configuring the 0-10V analogue voltage output

The analogue output generates a voltage which corresponds to the instantaneous mass or volume flow rate. It is intended to be connected to a data logger, multimeter or similar device with a high impedance input.

The relationship between measured flow rate and voltage is linear, and both the slope and offset are programmable.

Fixed lower and upper limits on the output voltage can be defined. The output voltage will not go outside these bounds regardless of flow rate. Use these to restrict the output voltage generated by the FCM to within the range that the connected device can accept.

(For example, many devices expect an input in the range 0 to 5V, in which case the upper limit should be set to 5V. This ensures the FCM will not generate higher voltages that may be out of range for the receiver).

An error condition can be unambiguously indicated by means of a fixed voltage which is outside the usual range. The analogue output will generate this voltage when any error condition exists which means it is unable to indicate an accurate flow rate.

Digital low-pass filter

The FCM has a digital low-pass filter which is dedicated to the analogue output. Its bandwidth may be set to any of a range of pre-set values in the range 1 Hz to 250 Hz. The

filter bandwidth should be set according to the sampling speed of the device to which the FCM is connected, and taking into account the desired trade-off between noise and bandwidth.

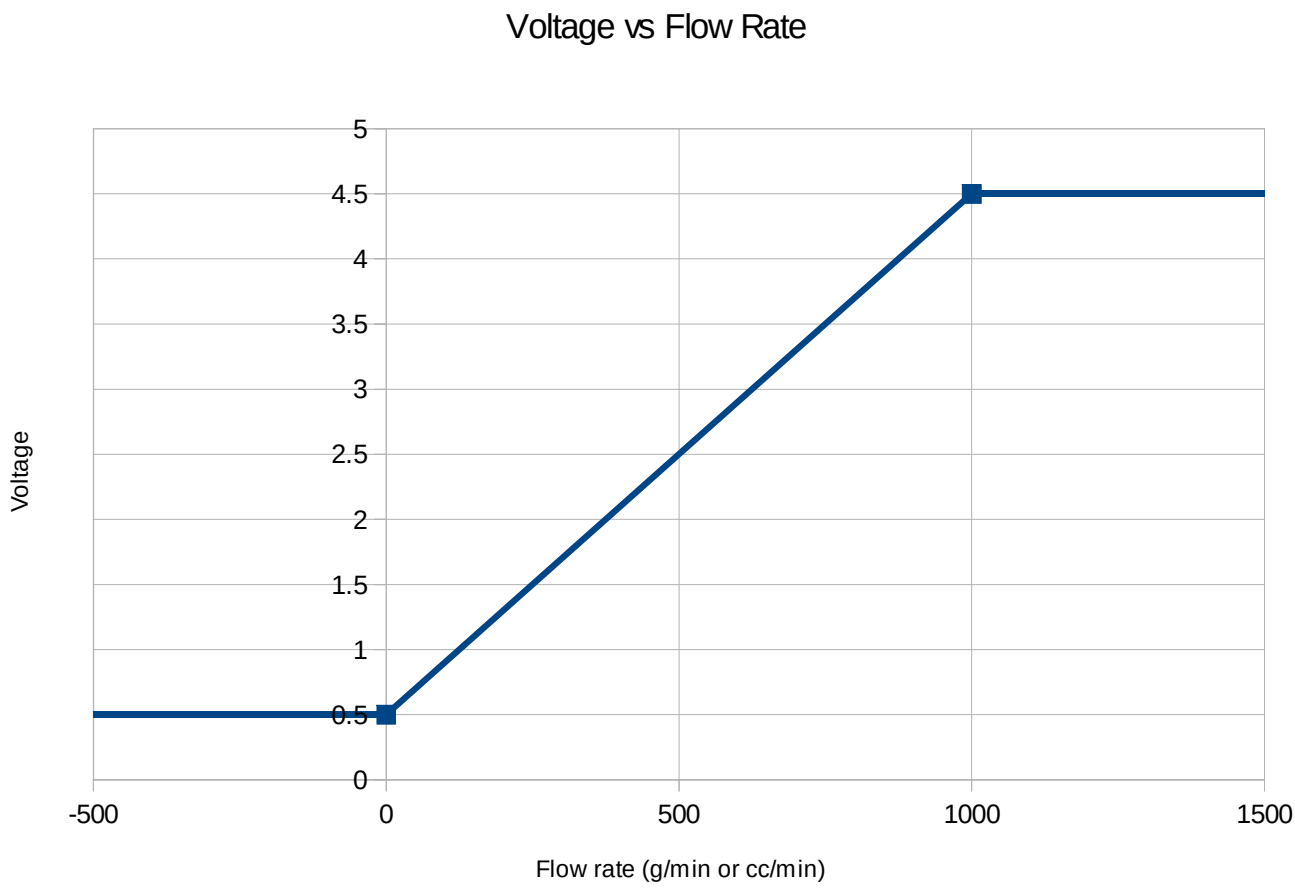
For example, if you are most interested in observing general trends, or making accurate measurements of the mean flow rate, then choose a low bandwidth and connect the analogue output to a high precision multimeter or data logger.

If, however, you would like to see how fuel moves in and out of the Meter as a result of vibration as an engine rotates, then choose a high bandwidth and connect the analogue output to an oscilloscope.

Note: the maximum bandwidth available on the analogue output of the FCM depends on the bandwidth available from the FlowSonic. See the section entitled "Configuring the Flow Sensor" for more details.

The voltage-flow relationship

The relationship between output voltage and flow rate is a straight line defined by two reference points, and hard lower and upper limits:



In this example:

- The lower reference point is at zero flow, 0.5V
- The upper reference point is at 1000 g/min, 4.5V
- The lower hard limit is 0.5V
- The upper hard limit is 4.5V

Note: it is not necessary for the two reference points to correspond with the fixed limits. For example, it would be perfectly valid to set one of the reference points to (500g/min, 2.5V), and this would not affect the behaviour of the analogue output at all. The FCM linearly interpolates between the two reference points, and extends the straight line relationship as necessary.

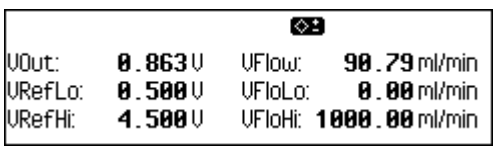
The voltage output menu

Menu option	**Function**
Show real time status	Displays various useful pieces of information about how the analogue voltage interface is configured, and what it is doing, in real time
Mass flow	The analogue voltage output indicates the mass flow rate
Volume flow	The analogue voltage output indicates the volume flow rate
Set low pass filter bandwidth	Sets the bandwidth of the low pass filter to one of a set of predefined values
Set lower reference point	Opens a sub-menu to define the voltage and flow rate of the lower reference point
Set upper reference point	Opens a sub-menu to define the voltage and flow rate of the upper reference point
Set lower limit	Sets the hard lower limit on the output voltage
Set upper limit	Sets the hard upper limit on the output voltage
Set error voltage	Sets the voltage which will be generated under error conditions
Disable voltage output	Disables the analogue voltage output

Note: the upper limit must always be equal to or greater than the lower limit. The FCM will not permit values to be entered which violate this condition.

Real time status
This screen shows how the analogue voltage interface is configured and what it is doing.

Example:



In this example, the voltage output is configured to indicate volumetric flow. When configured to indicate mass flow, the information presented on the status screen is modified accordingly.

The values displayed in this case are:

Label	**Quantity**	**Unit**
VOut	Voltage output	V
VFlow	Current volume flow rate	ml/min
VRefLo	Programmed lower voltage reference point	V
VFloLo	Programmed lower flow rate reference point	ml/min
VRefHi	Programmed upper voltage reference point	V
VFloLo	Programmed upper flow rate reference point	ml/min

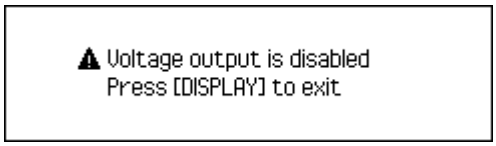
In this example:

- The programmed lower reference point is (0.5V, 0 ml/min)
- The programmed upper reference point is (4.5V, 1000 ml/min)
- The instantaneous measured volume flow rate is 90.79 ml/min

The output voltage in this example is given by:

V = 0.5 + (4.5 - 0.5) * (90.79 - 0) / (1000 - 0) = 0.863V

Note: the voltage output must be enabled for this screen to be available. If the voltage output is not enabled, an error is displayed:



Press [DISPLAY] to return to the main information display, then open the voltage output menu and select 'Mass flow' or 'Volume flow' to enable the port. The real-time status display is now available.

Calibration

The analogue voltage output can be calibrated to match the specific receiving device to which it is connected. This calibration is independent of the voltage-flow relationship defined above, and can significantly reduce errors introduced by differences in the reference standards used by the FCM and the receiving device.

Calibration can only be performed via the USB interface. Refer to the command line interface (Appendix B) for details of the calibration procedure.

Configuring the 4-20mA current output

The current loop output generates a current which corresponds to the instantaneous mass or volume flow rate. It is intended to be connected to equipment with a standard 4-20mA current loop input.

The relationship between measured flow rate and current is linear, and both the slope and offset are programmable.

Fixed lower and upper limits on the output current can be defined. The current will not go outside these bounds regardless of flow rate. Normally these are set to 4mA and 20mA respectively, though the FCM can generate currents down almost to 0mA or up to 25mA. This makes the FCM compatible with 0-20mA inputs as well.

An error condition can be unambiguously indicated by means of a fixed current which is outside the usual range. The 4-20mA output will pass this current when any error condition exists which means it is unable to indicate an accurate flow rate. For example, if the FCM uses the range 4mA to 20mA to indicate flow, it might be programmed to generate 2mA under error conditions.

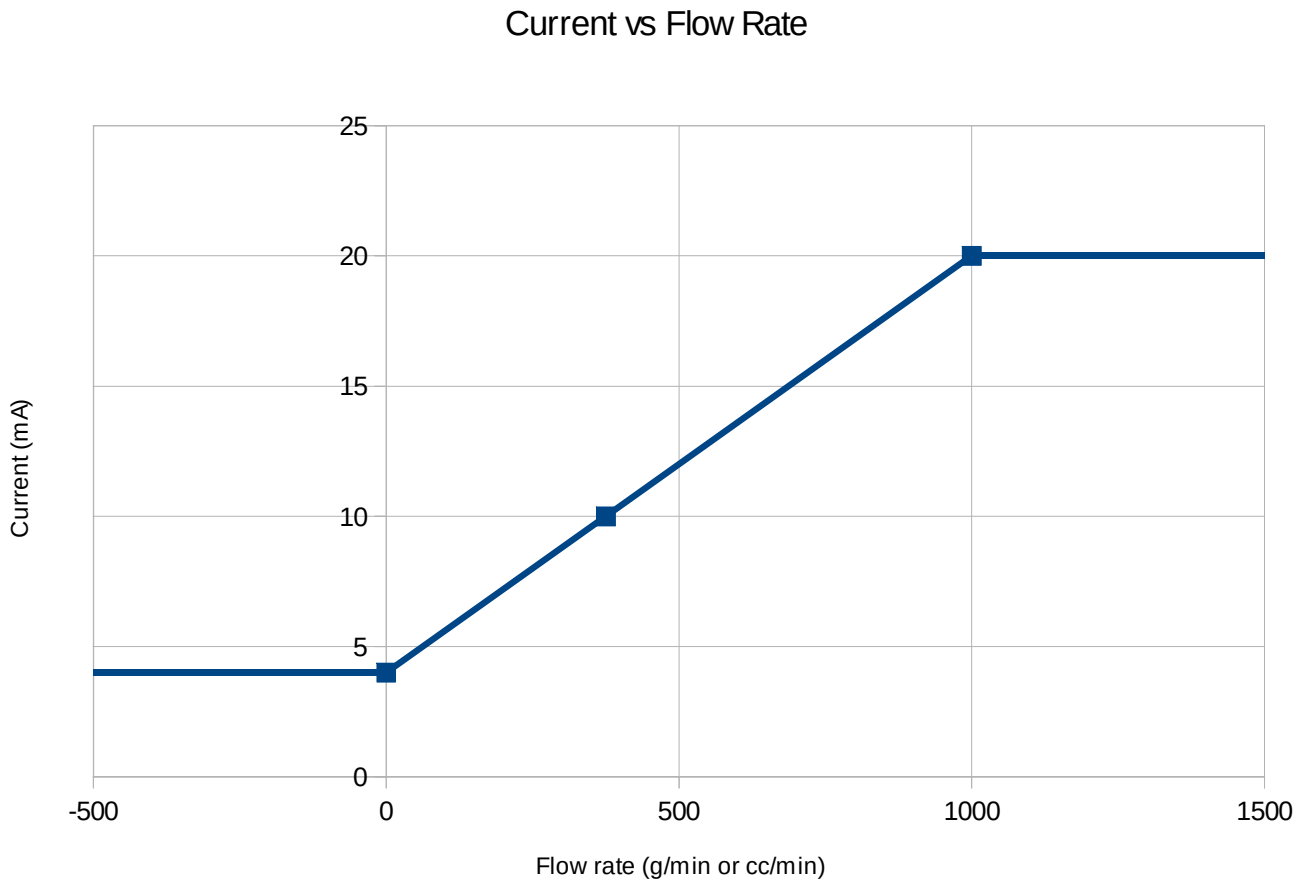
Digital low-pass filter

The FCM has a digital low-pass filter which is dedicated to the 4-20mA output. Its bandwidth may be set to any of a range of pre-set values in the range 1 Hz to 250 Hz. The filter bandwidth should be set according to the sampling speed of the device to which the FCM is connected, taking into account the desired trade-off between noise and bandwidth.

Note: the maximum bandwidth available on the analogue output of the FCM depends on the bandwidth available from the FlowSonic. See the section entitled "Configuring the Flow Sensor" for more details.

The current-flow relationship

The relationship between output current and flow rate is a straight line defined by two reference points, and hard lower and upper limits:



In this example:

- The lower reference point is at zero flow, 4.0mA
- The upper reference point is at 1000 g/min, 20.0mA
- The lower hard limit is 4.0mA
- The upper hard limit is 20.0mA

Note: it is not necessary for the two reference points to correspond with the fixed limits. For example, it would be perfectly valid to set one of the reference points to (375 g/min, 10.0mA), and this would not affect the behaviour of the analogue output at all because it sits on the same straight line relationship. The FCM linearly interpolates between the two reference points, and extends the straight line as necessary.

The 4-20mA output menu

Menu option	**Function**
Show real time status	Displays various useful pieces of information about how the 4-20mA interface is configured, and what it is doing, in real time
Mass flow	The 4-20mA output indicates the mass flow rate
Volume flow	The 4-20mA output indicates the volume flow rate

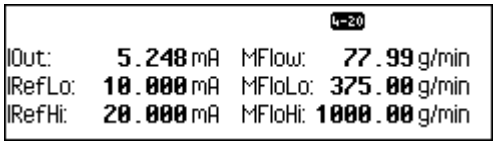
Set low pass filter bandwidth	Sets the bandwidth of the low pass filter to one of a set of predefined values
Set lower reference point	Opens a sub-menu to define the current and flow rate of the lower reference point
Set upper reference point	Opens a sub-menu to define the current and flow rate of the upper reference point
Set lower limit	Sets the hard lower limit on the output current
Set upper limit	Sets the hard upper limit on the output current
Set error current	Sets the current which will be generated under error conditions
Disable current output	Disables the 4-20mA output

Note: the upper limit must always be equal to or greater than the lower limit. The FCM will not permit values to be entered which violate this condition.

Real time status

This screen shows how the 4-20mA interface is configured and what it is doing.

Example:



In this example, the 4-20mA output is configured to indicate mass flow. When configured to indicate volumetric flow, the information presented on the status screen is modified accordingly.

The values displayed in this case are:

Label	**Quantity**	**Unit**
IOut	Current output	mA
MFlow	Current mass flow rate	g/min
IRefLo	Programmed lower current reference point	mA
MFloLo	Programmed lower flow rate reference point	g/min
IRefHi	Programmed upper current reference point	mA
MFloLo	Programmed upper flow rate reference point	g/min

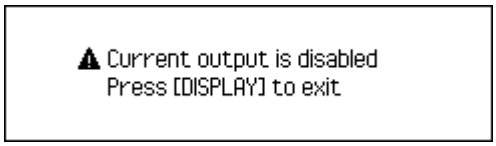
In this example:

- The 4-20mA interface is configured to output mass flow
- The programmed lower reference point is (10.0mA, 375 g/min)
- The programmed upper reference point is (20.0mA, 1000 ml/min)
- The instantaneous measured volume flow rate is 77.99 g/min

The output current in this example is given by:

I = 10.0 + (20 - 10)/(1000 - 375) * (77.99 - 375) = 5.248mA

Note: the 4-20mA output must be enabled for this screen to be available. If the output is not enabled, an error is displayed:



Press [DISPLAY] to return to the main information display, then open the 4-20mA output menu and select 'Mass flow' or 'Volume flow' to enable the port. The real-time status display is now available.

Calibration

The 4-20mA output can be calibrated to match the specific receiving device to which it is connected. This calibration is independent of the current-flow relationship defined above, and can significantly reduce errors introduced by differences in the reference standards used by the FCM and the receiving device.

Calibration can only be performed via the USB interface. Refer to the command line interface (Appendix B) for details of the calibration procedure.

Configuring the CAN bus

The CAN bus interface provides the most accurate and comprehensive data available from the FCM.

The FCM transmits three separate messages onto the CAN bus at regular intervals. These messages contain:

- Instantaneous mass and volume flow rates
- Fluid density and temperature
- Cumulative total mass and volume (totaliser output)

The FCM conforms to the CAN 2.0A (11 bit identifier) standard.

There must always be at least one other device on the CAN bus which is capable of receiving and acknowledging the data transmitted by the FCM. If there is no other device on the bus, or if there is a fault on the bus, the FCM will indicate this with a warning message:

Should this message appear, check that:

- The bus is physically connected correctly to the FCM
- The receiving device is enabled
- The FCM is configured to transmit at the same bit rate as the receiver and any other device on the bus
- There is enough free bandwidth on the CAN bus for all the traffic on it
- The CAN bus is terminated correctly at both ends, and nowhere else

Bit rate

The CAN bus supports a range of transmission speeds (bit rates).

All devices located on the same CAN bus must be configured to use the same bit rate. Configure the FCM to use the same bit rate as the other devices on the bus.

Digital low-pass filter

The FCM has a digital low-pass filter which is dedicated to the CAN bus output. Its bandwidth may be set to any of a range of pre-set values in the range 1 Hz to 250 Hz. The filter bandwidth should be set according to the rate at which CAN messages are transmitted, and taking into account the desired trade-off between noise and bandwidth.

The bandwidth of this filter should be set no higher than 0.5x the frequency with which CAN messages are transmitted onto the bus, to avoid errors due to aliasing (Nyquist sampling criterion must be met).

For example, if the interval between CAN messages is set to 10ms, the message rate is equal to 100 Hz. Therefore, in order to meet the Nyquist criterion, the bandwidth of the low-pass filter should be set no higher than 50 Hz.

Note: the maximum bandwidth available on the analogue output of the FCM depends on the bandwidth available from the FlowSonic. See the section entitled "Configuring the Flow Sensor" for more details.

Message interval

Temperature, density and cumulative totals are always transmitted by the FCM at regular, timed intervals. The interval can be set between 1ms and 1000ms.

The FCM supports two different ways to control the time interval between consecutive messages which carry the instantaneous flow rate, either:

- The same fixed, programmed interval as used for the other CAN messages, or
- A one-for-one mode, in which CAN messages containing flow data are transmitted immediately following corresponding messages received by the FCM from the FlowSonic

The one-for-one mode may be useful in the following circumstances:

- If the instantaneous flow rate is to be transmitted more frequently than the other information in order to save CAN bus bandwidth
- If different FlowSonic units are used with the FCM, some of which are configured to measure and transmit data with higher bandwidth than others, and it is undesirable to have to reconfigure the FCM each time the Meter is changed

The CAN bus menu

Menu option	**Function**
Enable CAN bus	Enables transmission of data onto the CAN bus
Set CAN base id	Assign the base ID with which CAN messages will be sent
Set message interval	Sets the time between consecutive CAN messages
Set low pass filter bandwidth	Sets the bandwidth of the low pass filter to one of a set of predefined values
Flow message trigger	Determines whether flow messages are sent at regular intervals controlled by the FCM, or are relayed one-for-one as they are received from the FlowSonic
Set CAN bit rate	Sets the bit rate on the CAN bus
Disable CAN bus	Disables the CAN bus interface

CAN message format

The format of the messages transmitted by the FCM is as follows.

All fields which span multiple bytes are MSB first.

Flow rate message

Msg ID	Data bytes							
	0	1	2	3	4	5	6	7
Base	Volume flow in 0.01 ml/min Signed 32-bit int				Mass flow in 0.01 g/min Signed 32-bit int			

Example

Suppose:

- mass flow rate = 200 g/min
- volume flow rate = 250 ml/min
- CAN base ID is 0x390

The corresponding message would be (all values in Hex):

Msg ID	Data bytes							
	0	1	2	3	4	5	6	7
390	00	00	61	A8	00	00	4E	20

If the mass flow or volume flow rates cannot be measured for some reason, this is indicated via the CAN bus by the value 0x7FFFFFFF. For example, this value may be shown if the Meter becomes disconnected, or if the external density meter fails to provide valid data.

Density and temperature message

Msg ID	Data bytes							
	0	1	2	3	4	5	6	7
Base + 1	Density in 0.0001 g/ml Unsigned 16-bit int		DM_ TYPE	0	FS temperature in 0.01°C Signed 16-bit int		DM temperature in 0.01°C Signed 16-bit int	

DM_TYPE is a flag indicating the type of density meter in use:

DM_TYPE	**Meaning**
0	FlowSonic programmed density-temperature relationship
1	External density meter

FS temperature is the temperature as measured by the FlowSonic.
DM temperature is the temperature as measured by the external density meter, if a density meter is in use (indicated by DM_TYPE = 1). If there is no external density meter in use, then this field is a duplicate of temperature reading from the FlowSonic.

Example

Suppose:

- Fuel density = 0.8161 g/ml
- External density meter is in use
- Fuel temperature = 44.2 °C at the flow sensor
- Fuel temperature = 45.7 °C at the density meter
- CAN base ID is 0x390

The corresponding message would be (all values in Hex):

Msg ID	Data bytes							
	0	1	2	3	4	5	6	7
391	1F	E1	01	00	01	BA	01	C9

If an external density meter is selected, but it fails to provide valid data:

- The density value is set to 0000
- The DM temperature is 0000

Cumulative totals message

Msg ID	Data bytes							
	0	1	2	3	4	5	6	7
Base + 2	Cumulative total volume in 0.01ml Signed 32-bit int				Cumulative total mass in 0.01g Signed 32-bit int			

Example

Suppose:

- cumulative total mass = 4577.21 g
- cumulative total volume = 6611.94 ml
- CAN base ID is 0x390

The corresponding message would be (all values in Hex):

Msg ID	Data bytes							
	0	1	2	3	4	5	6	7
392	00	0A	16	CA	00	06	FB	F9

Using the FCM with an external density meter

Ultrasonic flow meters, including the FlowSonic, inherently measure volumetric flow.

To determine the mass flow rate, the density of the fluid must be known. The FCM can determine this in two ways:

- Use a programmed density-temperature relationship, which is a characteristic of the fluid, and is usually available from the manufacturer of the fuel
- Use a separate density meter to measure the fluid density in situ

The FlowSonic can be programmed with a known temperature-density relationship. Based on this information, and knowledge of the fluid temperature from its own temperature sensors, it can calculate the expected density. The FCM can use this to convert volumetric flow into mass flow.

Alternatively, the FCM can use real-time density information from a separate density meter. The FCM provides an RS232 compatible serial interface and accepts data from a

range of common 3rd party density meters. Refer to Appendix C for details of the data format expected by the FCM.

The density meter menu

Menu option	Function
Use flow sensor	The FlowSonic programmed temperature-density relationship is used to determine the density
External density meter	Use density information from an external density meter
Configure RS232 interface	Opens a sub-menu allowing the baud rate, parity and word length on the RS232 interface to be set

RS232 settings menu

Menu option	Function
Set baud rate	Set the RS232 baud rate (range 1200 to 115200)
Set parity	Set the RS232 parity (none, odd or even)
Set word length	Set the RS232 word length (7 or 8 bits)

When the external density meter is enabled

- The density icon  appears in the icon area at the top of the LCD
- The FCM will ignore the calculated density figure provided by the FlowSonic
- The density meter is expected to provide data at regular intervals (~1 Hz)

If the density meter fails to provide the expected data:

- The FCM will display a warning: 

- Mass flow and density values become unavailable
- If the analogue voltage and/or 4-20mA outputs are configured to indicate mass flow, they will instead indicate an error condition
- The CAN bus will indicate a value of 0x7FFFFFFF for mass flow, and 0 for density

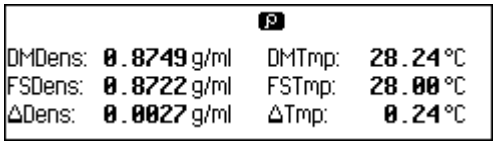
If this happens, check that the density meter is powered on and is correctly connected to the RS232 port on the FCM.

It is also necessary to set the RS232 port settings on the FCM to match those on the density meter. If these are incorrect, the FCM may indicate this with another warning:

In this event, check that the baud rate, parity and word length on the FCM match those on the density meter.

Comparing data from the density meter vs the FlowSonic

The FCM includes an information screen which shows side-by-side the temperature and density values being provided by the density meter and the FlowSonic:



To access this screen, press [DISPLAY] to cycle through all the available options until it appears.

In this example, the programmed temperature-density relationship in the FlowSonic predicts a density of 0.8722 g/ml, and the density meter measures 0.8749 g/ml, a difference of 0.0027 g/ml. The temperatures recorded by the two instruments are also compared.

Configuring the Flow Sensor

The FlowSonic supports a number of configuration settings which alter the content and frequency of data which it transmits onto its CAN bus. The FCM must be configured to match, so that data from the FlowSonic can be correctly identified and interpreted.

The Flow Sensor Menu

Menu option	**Function**
Auto detect flow sensor	Read the configuration directly out of the FlowSonic and configure the FCM accordingly
Set sensor CAN ID	Manually set the base CAN ID used by the FlowSonic
Set CAN template	Manually set the format of the CAN data produced by the FlowSonic
Set CAN unit divisor	Manually set the units of measurement used on the CAN bus by the FlowSonic

Auto detecting settings

The FCM can read the settings straight from the FlowSonic and configure itself automatically to match. This is the recommended way to configure the FCM.

This process may be triggered by either:

- Selecting the 'auto detect flow sensor' option from the menu, or
- Pressing and holding the [RESET] button for three seconds

It can also be initiated by a command via the USB interface.

Manually setting the CAN ID

Under some circumstances it may be necessary to set the CAN ID manually; for example, if there are multiple FlowSonic meters on the same CAN bus.

Enter the CAN ID in Hex using the [UP], [DOWN] and [OK] buttons.

Setting the CAN template

The CAN template refers to the format of the messages transmitted onto the CAN bus by the FlowSonic.

The template depends on the specific FlowSonic model being used:

- The FlowSonic LF sensor uses the “enhanced” CAN template
- The FlowSonic Elite sensor uses the “legacy” CAN template

Ensure this is set correctly according to the model of FlowSonic being used. Setting this incorrectly will result in an erroneous flow rate, or no flow rate, being recorded.

Setting the CAN unit divisor

The CAN unit divisor refers to the ratio between the units used by the FlowSonic on the CAN bus, and its internal units which are always 0.01g/min for mass flow and 0.01 ml/min for volume flow.

The default values are:

- 1 for sensors using the “enhanced” CAN template
- 50 for sensors using the “legacy” CAN template

This value must match the `CANDIVISORS` settings on the FlowSonic.

Note, only the first `CANDIVISORS` parameter is used, because the FCM does not use the totaliser in the FlowSonic itself.

Example:
If the FlowSonic is set to `CANDIVISORS 10 1000`, then the FCM CAN unit divisor must be set to 10.

Other important FlowSonic settings

To obtain the maximum available measurement bandwidth, the digital low-pass filter on the Meter's CAN output needs to be configured to maximum bandwidth, and its CAN message rate must be set to a high enough rate.

The FCM includes its own digital low-pass filters on each of its outputs, so if a lower bandwidth is required than the bandwidth available from the Meter, the FCM can perform the necessary filtering without the need to change any settings on the FlowSonic.

Since the CAN interface between the FlowSonic and the FCM is fast (1 Mbps), and typically has no other devices on it, it is recommended to set the CAN message rate on the Meter to the highest possible speed using the `CANRATE` command.

The maximum bandwidth available from the FlowSonic depends on whether it has the OPT_HIGH_BW licence. Without the licence, the maximum bandwidth is 50 Hz. With it, the maximum is 250 Hz.

Note: these figures apply to the FlowSonic LF product. The FlowSonic Elite is factory set to 25 Hz and cannot be changed. The following instructions apply to FlowSonic LF only.

To configure the FlowSonic for the best available bandwidth:

- Connect the FCM to a PC using the USB connection.
- Connect the FlowSonic to the FCM if not already attached.
- Run serial terminal emulation software on the PC.
- Enter the serial command `FS`. This passes serial traffic transparently to and from the FlowSonic, and allows access to its command line interface.

Without OPT_HIGH_BW:

- Enter `FILTER 50`
- Enter `CANRATE 10 100 100`

With OPT_HIGH_BW:

- Enter `FILTER 250`
- Enter `CANRATE 1 100 100`

Finally, type the escape sequence `%%%` to take the FCM out of transparent mode, ie. finish the connection to the FlowSonic and return to the FCM's own command line.

Adjusting the LCD display

The FCM includes a screen saver, which automatically dims the LCD backlight after a period of inactivity in order to save power and preserve the brightness of the LEDs.

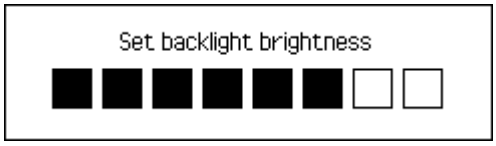
The brightness and contrast of the LCD can also be adjusted for comfort and readability.

The Display Menu

Menu option	**Function**
Brightness	Set the brightness of the LCD backlight
Contrast	Set the contrast of the LCD
Screen saver	Set the time between the last activity (key press) and the backlight being dimmed

Adjusting the brightness

The brightness of the LCD backlight can be adjusted in nine steps from off to full brightness. Use the [UP] and [DOWN] keys to increase and decrease the brightness, and [OK] to confirm and store the new setting.

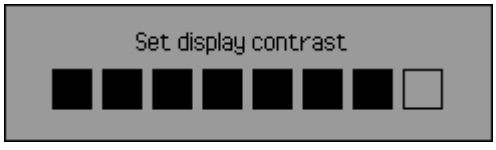


Adjusting the contrast

The contrast of the LCD can be adjusted for best readability. Decreasing the contrast makes the screen lighter, while increasing it makes the screen darker. Use the [UP] and [DOWN] keys to adjust the contrast and [OK] to confirm and store the new setting.

Low contrast:

High contrast:



The screen saver

The screen saver automatically dims the backlight after a period when no buttons have been pressed. Choose from 10, 30 or 60 seconds, or disable the screen saver entirely.

It is recommended to enable the screen saver, to save power and preserve the LEDs. Although LEDs have a long service life, the FCM is intended to be kept powered up for extended periods of time, and eventually the LEDs will lose brightness.

System information

The system information screen displays various information about the FCM:

- The specific model number
- Firmware revision and date
- The total number of hours for which the FCM has been powered up
- The serial number

Press any key to exit this screen and return to normal operation.

Appendix A: Specifications

Power supply

Supply type	Single phase AC
Connector type	IEC 60320 type C14
Voltage range	85 - 264V
Frequency range	47 - 63 Hz
Power rating	15W
Fuse type	2A anti-surge

Environmental

Ambient temperature	0 - 45 °C
Humidity	0 - 95% RH non-condensing
Altitude	0 - 3000m
Cooling	Convection

Flow sensor

<Insert details of flow sensor connector>

Density meter

Connected device	3rd party density meter
Type	D-type
Gender	Male
Number of pins	9
Isolation	Common ground with flow sensor Isolated from local earth
Signalling	RS232 compatible
Output level	High level min. +5.0V Low level max -5.0V
Input level	High level min +2.4V Low level max +1.5V
Data rates	115200, 57600, 38400, 19200, 14400, 9600 (default), 4800, 2400, 1200
Parity	None (default), odd, even
Word length	7 bits, 8 bits (default)

<Insert diagram of D-type male connector looking into connector from outside>

Pin	Name	Function	Direction
1	nc	No connection	
2	RxD	Receive data	In to FCM
3	TxD	Transmit data	Out from FCM
4	nc	No connection	
5	GND	Density meter and flow meter ground	
6	nc	No connection	
7	RTS	Flow control *	Out from FCM
8	CTS	Flow control *	In to FCM
9	nc	No connection	

* the FCM does not use flow control. Leave these pins unconnected.

USB connector

Connected device	General purpose PC (USB host)
Type	USB 2.0 Type B
Gender	Female
Number of pins	4
Isolation	Not isolated
Signalling	USB 2.0

<Insert diagram of USB B female connector looking into connector from outside>

Pin	Name	Function	Direction
1	VBUS	+5V power from PC	In to FCM
2	D-	Data -	Bidirectional
3	D+	Data +	Bidirectional
4	GND	Ground	

CAN bus

Connected device	CAN based data logger
Type	D-type
Gender	Female
Number of pins	9
Isolation	Isolated from local earth

Signalling	ISO 11898-2 and ISO-11898-5 compliant
Output level	CANH - CANL = 2.2V (typ) (dominant) CANH - CANL = 0V (typ) (recessive)
Drive capability	50-65 Ohms
Termination	Optional internal 120 Ohm termination Bus must be terminated with 120 Ohms at each end
Data rates	1 Mbps (default), 500k, 250k, 125k, 100k
CAN identifier	CAN 2.0A (11 bit standard only)

<Insert diagram of D-type female connector looking into connector from outside>

Pin	Name	Function	Direction
1	nc	No connection	
2	CANL	CAN bus data	Bidirectional
3	GND	Ground connection	
4	nc	No connection	
5	nc	No connection	
6	nc	No connection	
7	CANH	CAN bus data	Bidirectional
8	nc	No connection	
9	nc	No connection	

4-20mA current loop connector

Connected device	4-20mA current loop receiver
Connector part	CamdenBoss CTB932HE/3
Mating part	CamdenBoss CTB922HE/3
Type	Screw terminal
Number of pins	3
Isolation	Isolated from local earth
Signalling	4-20mA current loop
Internal power supply	+12V @ 30mA maximum

<Insert diagram of 4-20mA current loop connector with pin numbering>

Pin	Name	Function	Direction
1	Power	Power output	Out from FCM
2	Current	Current sink	In to FCM

3	GND	Ground connection	

Totaliser control / logic input

Connected device	Switch, relay or digital logic signal
Connector part	CamdenBoss CTB932HE/2
Mating part	CamdenBoss CTB922HE/2
Type	Screw terminal
Number of pins	2
Isolation	Common ground with TTL output Isolated from local earth
Signalling	Digital logic input Internal 4 kOhm pull up to +5V
Voltage levels	High level: +2.0V to +24V Low level: 0V to 0.4V

<Insert diagram of logic input connector with pin numbering>

Pin	Name	Function	Direction
1	Input	Logic input	In to FCM
2	GND	Ground connection	

TTL pulse output

Connected device	Data logging device with digital logic input
Type	BNC
Isolation	Common ground with digital logic (totaliser) input Isolated from local earth
Signalling	0 - 5V digital pulse
Maximum pull-up voltage	+24V
Output impedance	50 Ohm (nominal)

<Insert diagram of BNC connector>

Pin	Name	Function	Direction
1	TTL out	TTL pulse output	Out from FCM
2	GND	Ground connection	

0-10V analogue voltage output

Connected device	Data logging device with analogue voltage input
Type	BNC
Isolation	Isolated from local earth
Signalling	0 - 10V analogue voltage (Range can be restricted by configuration)
Maximum current	10 mA
Load impedance	Greater than 1 kOhm

<Insert diagram of BNC connector>

Pin	Name	Function	Direction
1	VOut	Analogue voltage output	Out from FCM
2	GND	Ground connection	

Appendix B: Command line interface specifications

Configuring the FCM from a PC

The FCM features a USB interface, which allows it to appear to a host PC as a virtual COM port, through which the PC can communicate with the FCM using standard serial terminal emulator software.

To communicate over USB:

- Switch off power to the FCM by unplugging the mains connector, or using the switch on the front panel.
- Connect the FCM to the PC using a good quality, standard USB A-B cable (refer to the section entitled “Connecting to a PC via USB”).
- Switch on the PC and allow it to boot fully.
- Switch on the FCM.
- The FCM uses a Silicon Labs CP2102N USB to UART bridge. The PC should detect this device and, if necessary, automatically fetch the appropriate drivers from the manufacturer or OS provider's web site. An active internet connection is required.
- It may be necessary to reboot the PC once the drivers have been installed.
- Launch your preferred terminal emulator software (Sentronics recommends the free, open source “Tera Term” version 4.85 or later)
- Select the correct COM port, and configure the UART settings to 115200 baud, 8 data bits, no parity, 1 stop bit
- To test the connection, enter `VER` and press [ENTER]. The FCM should return a string containing its firmware version number and date, followed by “`# OK`”.

The FCM provides a command line interface, through which the configuration of the FCM can be queried and modified.

When connected to a host PC via the USB connection, the FCM appears to the host as a virtual COM port, which in turn is connected to the internal processor. Communication may be carried out using custom software on the PC, or alternatively, through standard serial terminal emulation software.

FCM Command Line Reference

The following commands are recognised by the FCM. They are described in more detail below.

Command: BRIGHTNESS <n>

Sets the brightness of the LCD backlight. <n> takes value from 0-8.

Example: Set the brightness of the LCD to approximately half of perceived maximum

```
BRIGHTNESS 4
```

Command: CONTRAST <n>

Sets the contrast of the LCD display. <n> takes value from 0-8.

Example: Set the contrast of the LCD to the middle of the available range:

```
CONTRAST 4
```

Command: SSTIME <n>

Sets the amount of time between the last key press and when the screen saver will automatically dim the brightness of the LCD backlight.

Valid values are 0 (disables screen saver), 10, 30 or 60 seconds.

Example: Set the screen saver time-out value to 10 seconds

```
SSTIME 10
```

Command: CAL_ILOOP <p> <v>

This command is used to adjust the current produced by the 4-20mA current loop output.

The purpose of the 4-20mA output is to accurately convey *information* to the receiving device, not to act as a laboratory standard current reference. Greater accuracy of the overall system is achieved if the FCM produces a signal which is correct *according to the receiving device* than if it is 'correct' in an absolute sense.

Therefore, the capability is provided to apply an adjustment to the output produced by the FCM, in order to compensate for any systematic errors and offsets in the system as a whole.

The adjustment is made by generating two reference currents, one near the low end of the available range, and one near the high end. At each point, the current (as measured by the receiver) is programmed into the FCM. The FCM can then interpolate between (and outside) these points, to achieve any desired reading at the receiver.

The procedure is as follows:

- Enter `CAL_ILOOP 0`.
- The FCM generates a reference current which is approximately 4 mA.
- Measure the reference current using the receiving device.
- Enter `CAL_ILOOP 0 v`, where <v> is the actual measured current in µA.
- Enter `CAL_ILOOP 1`.
- The FCM generates a reference current which is approximately 20 mA.
- Measure the reference current using the receiving device.

- Enter `CAL_ILOOP 1 v`, where <v> is the actual measured current in µA.

Example: assume FCM is connected to a multimeter set to 100mA DC current range

- Enter `CAL_ILOOP 0`
- Multimeter reads +004.0406 mA
- Enter `CAL_ILOOP 0 4041`
- Enter `CAL_ILOOP 1`
- Multimeter reads +020.0379 mA
- Enter `CAL_ILOOP 1 20038`

The FCM is now calibrated.

Tip: to check the calibration, enable the current loop interface by selecting either mass flow or volume flow as the data source, then temporarily set both the upper and lower hard limits to the same value. This will ensure the output current is set to exactly the same value regardless of the actual flow rate. Alternatively, set the port's 'error current' to a known value, and disconnect the FlowSonic to force an error condition.

Command: CAL_VOUT <p> <v>

This command is used to adjust the voltage produced by the 0-10V analogue voltage output.

The purpose of the 0-10V output is to accurately convey *information* to the receiving device, not to act as a laboratory standard voltage reference. Greater accuracy of the overall system is achieved if the FCM produces a signal which is correct *according to the receiving device* than if it is 'correct' in an absolute sense.

Therefore, the capability is provided to apply an adjustment to the output produced by the FCM, in order to compensate for any systematic errors and offsets in the system as a whole.

The adjustment is made by generating two reference voltages, one near the low end of the available range, and one near the high end. At each point, the voltage (as measured by the receiver) is programmed into the FCM. The FCM can then interpolate between (and outside) these points, to achieve any desired reading at the receiver.

Note: The upper reference point is set to +4.5V, in order that 0-5V inputs can benefit from the adjustment process without being overloaded by a voltage which is out of range.

The procedure is as follows:

- Enter `CAL_VOUT 0`.
- The FCM generates a reference voltage which is approximately 0.5V.
- Measure the reference voltage using the receiving device.
- Enter `CAL_VOUT 0 v`, where <v> is the actual measured voltage in µV.
- Enter `CAL_VOUT 1`.
- The FCM generates a reference voltage which is approximately 4.5V

- Measure the reference voltage using the receiving device.
- Enter `CAL_VOUT 1 v`, where <v> is the actual measured voltage in µV.

Example: assume FCM is connected to a multimeter set to 10V DC voltage range

- Enter `CAL_VOUT 0`
- Multimeter reads +00.48962 V
- Enter `CAL_VOUT 0 489620`
- Enter `CAL_VOUT 1`
- Multimeter reads +04.48542 V
- Enter `CAL_VOUT 1 4485420`

The FCM is now calibrated.

Command: DD <n>

This command displays the configuration of the FCM.

Entering DD alone shows the information which is typically needed to describe how the FCM is set up.

To display additional information, enter DD 1. This produces a more complete set of information, including the following additional data which is specific to an individual FCM unit:

- Firmware revision and date
- Serial number
- Total time for which the FCM has been powered up
- Display brightness, contrast and screen saver settings
- Calibration data for the 0-10V and 4-20mA outputs

Example:

```
dd 1
# Device part number: Sentronics FCM01

F/w version 0.03 8 Feb 2017

# FCM serial number: 12345

# Total power-on time (secs)
18138

# Display brightness
BRIGHTNESS 8

# Display contrast
CONTRAST 4
```

```
# Screen saver timeout
SSTIME 0

# Voltage output calibration
CAL_VOUT 0 499969
CAL_VOUT 1 4499958

# Current loop output calibration
CAL_ILOOP 0 4000
CAL_ILOOP 1 20000

# Flow sensor CAN id, template selection and units
FSCAN x290 1 1

# Voltage output mode [0 (off), 1 (mass), 2 (volume)]
VOUTMODE 0

# Voltage output mapping between flow (g/min or ml/min) and
voltage (mV)
VOUTMAP 0 0 0
VOUTMAP 1 1000 10000

# Limits on output voltage (mV)
VOUTLIMIT 0 0
VOUTLIMIT 1 10000

# Voltage during error conditions (mV)
VOUTERR 0

# Filter bandwidth on voltage output (Hz)
VOUTFILTER 250

# Current loop mode [0 (off), 1 (mass), 2 (volume)]
ILOOPMODE 0

# Current loop mapping between flow (g/min or ml/min) and current
(uA)
ILOOPMAP 0 0 4000
ILOOPMAP 1 1000 20000

# Limits on output current (uA)
ILOOPLIMIT 0 4000
ILOOPLIMIT 1 20000

# Current during error conditions (uA)
ILOOPERR 0

# Filter bandwidth on current output (Hz)
ILOOPFILTER 20

# TTL pulse mode [0 (off), 1 (mass), 2 (volume)]
```

```
TTLMODE 1

# TTL pulses per cc or per g
TTLSCALE 1000

# Filter time constant on TTL output
TTLFILTER 99

# External CAN enable and message id
ECAN 0 x390

# External CAN message interval (msec)
ECANRATE 10

# External CAN bit rate (kb/s)
ECANBAUD 1000

# External CAN flow messages match sensor one-for-one
ECANMATCH 0

# Density meter type
DMTYPE 0

# Density meter RS232 settings
DMSERIAL 9600 8 0

# Totaliser mode and sense of logic input
TOTALMODE 1 0

# OK
```

Command: DMSERIAL <b> <w> <p>

This command sets the RS232 parameters on the density meter serial interface.

<b> is the baud rate.
<w> is the word length.
<p> is the parity type

Parity is defined as follows:

<p> value	Parity
0	None
1	Odd parity
2	Even parity

Example: Set the density meter interface to 38400 baud, 8 bits, even parity

```
DMSERIAL 38400 8 2
```

Command: DMTYPE <n>

Sets the type of density meter in use.

<n> takes values as follows:

<n> value	Density meter
0	FlowSonic computed value based on defined temperature-density relationship
1	External density meter

Example: Enable the external density meter

```
DMTYPE 1
```

Command: ECAN <e> <id>

Enables or disables the external (user) CAN bus interface, and sets the base ID on which messages are transmitted.

Set <e> = 0 to disable the CAN interface, or =1 to enable it.

The Base ID is often specified in Hex. To specify a Hex value, precede the value with a single 'x' character.

Example: Enable the CAN interface with base ID 256 (equals 100 in Hex)

```
ECAN 1 x100
```

Command: ECANBAUD <n>

Sets the bit rate used on the CAN interface, in kb/s. Set this to match the other devices on the CAN bus.

Example: Set the CAN interface to 1 Mbps

```
ECANBAUD 1000
```

Command: ECANRATE <n>

Sets the interval between consecutive CAN messages, in msec.

This interval always applies to messages carrying temperature/density and cumulative totals. It applies to messages containing flow rate, if the FCM is also programmed to transmit these at regular intervals (refer to ECANMATCH command below).

Example: Transmit groups of CAN messages at 100 msec intervals

```
ECANRATE 100
```

Command: ECANMATCH <n>

Determines how the time interval between consecutive CAN messages containing flow rate is controlled:

<n> value	Meaning
0	Flow messages are transmitted at regular intervals governed by the ECANRATE setting
1	Flow messages are transmitted immediately after CAN messages containing flow data are received from the FlowSonic by the FCM

Example: Set the CAN interface to transmit flow messages at a rate which depends on how the FlowSonic meter is configured

```
ECANMATCH 1
```

Command: FACTORY_RESET

This sets all the configurable settings on the FCM back to their factory defaults. Use with caution.

Example: Set the FCM to a known state before making other changes

```
FACTORY_RESET
```

Command: FS

Puts the FCM into a 'transparent' mode, in which serial traffic is passed directly to and from the FlowSonic, rather than being interpreted by the FCM itself.

This is useful to check and alter the configuration of the FlowSonic, without having to unplug it from the FCM to make changes.

To exit this mode, send the sequence %%%. This special sequence, which is not used by any FlowSonic command, is recognised by the FCM. (Note: the %%% sequence is not echoed back to the PC, so it is not normally visible in the terminal window).

Example: Check the firmware version in the FlowSonic

```
fs
# Flowmeter command line interface, type %%% to exit

ver
# STM32 version 2.02 26 Jan 18
# Software checksum x2712
# FPGA version 227
# Boot loader version 11
# Boot loader checksum xA5E3
# OK

%%%
# Flow sensor CLI exit OK
```

Command: FSCAN <id> <e> <d>

Configures the FCM to match the CAN interface settings in use on the FlowSonic.

The parameters are:

Parameter	Meaning
<id>	The Base ID used by the FlowSonic. This depends on the specific product type, and the configuration of the unit. The FlowSonic command CANINFO may be used to determine how the CAN ID is set.
<e>	The CAN template in use. This depends on the FlowSonic model and licence. Set e = 0 for Meters without OPT_ENHANCED_CAN (Elite models) Set e = 1 for Meters with OPT_ENHANCED_CAN (LF models)
<d>	The CAN unit divisor (CANDIVISORS setting). The default values are: 50 for Meters without OPT_ENHANCED_CAN (Elite models) 1 for Meters with OPT_ENHANCED_CAN (LF models)

The Base ID is often specified in Hex. To specify a Hex value, precede the value with a single 'x' character.

The CANDIVISORS setting relating to cumulative total flow is ignored, because the FCM does not use the totaliser in the FlowSonic.

Example: Set the FCM to use a FlowSonic LF with default settings

```
FSCAN x290 1 1
```

Example: Set the FCM to use a FlowSonic Elite with default settings

```
FSCAN x190 0 50
```

Command: LEARNFS

Automatically interrogate the FlowSonic, and configure the FCM to match its settings.

This command initiates the same procedure as pressing and holding the [RESET] button. It uses a dedicated serial connection to the FlowSonic to query and extract its settings, and configures the `FSCAN` settings accordingly.

In addition, settings retrieved from the FlowSonic are shown via the serial interface.

The learning process may take several seconds to complete, or may be virtually instantaneous, depending on the FlowSonic model used and the licensed options it has.

Example: Learn the settings in use on a newly attached FlowSonic

```
learnfs
# Sensor part number = FS-100-00
# Sensor serial number = 772
# Sensor PCB serial number = 111
# Sensor configured CAN ID = x0 (resistor select)
# Divisor to convert CAN units into 0.01g / 0.01cc = 1
# Sensor's programmed fuel density, slope and reference
temperature
FD 875000 -100 0
# Sensor low-pass filter bandwidth = 20
# Flow sensor info received OK
# OK
```

Command: ILOOPMODE <n>

Controls the function of the 4-20mA current loop output. Set the value of <n> to select a mode as follows:

<n> value	Meaning
0	4-20mA current loop is disabled and delivers zero current
1	4-20mA current loop indicates mass flow rate
2	4-20mA current loop indicates volumetric flow rate

Example: Set the current loop to indicate mass flow

```
ILOOPMODE 1
```

Command: ILOOPMAP <p> <f> <i>

Sets the straight line relationship between measured flow rate and the current delivered via the 4-20mA interface. The relationship is a straight line defined by two reference points.

The parameters are as follows:

Parameter	Function	Unit
<p>	Determines which reference point is being set Set p=0 to program the lower reference point Set p=1 to program the upper reference point	Index
<f>	Flow rate at the reference point	g/min (for mass flow) ml/min (for volume flow)
<i>	Current at the reference point	µA

Example: Set the 4-20mA current loop to span a range from 0 to 1000 g/min mass flow

```
ILOOPMAP 0 0 4000
ILOOPMAP 1 1000 20000
```

Command: ILOOPLIMIT <p> <i>

Sets the hard lower and upper limits on the current produced by the 4-20mA interface.

The parameters are as follows:

Parameter	Function	Unit
<p>	Determines which reference point is being set Set p=0 to program the lower limit Set p=1 to program the upper limit	Index
<i>	Current limit value	µA

Example: Constrain the 4-20mA interface to a maximum of 15 mA

```
ILOOPLIMIT 0 4000
ILOOPLIMIT 1 15000
```

Command: ILOOPERR <i>

Sets the current which will be generated by the 4-20mA interface under conditions where the flow rate cannot be measured. This may, for example, be because it is programmed to indicate mass flow making use of an external density meter, but the density meter is switched off.

The parameter <i> is in units of µA.

Example: Set the current under error conditions to be 2 mA

```
ILOOPERR 2000
```

Command: ILOOPFILTER <b>

Sets the bandwidth of the digital low pass filter applied to the 4-20mA interface.

The value <b> is in Hz.

Note, the maximum bandwidth actually available cannot exceed the bandwidth of the flow data provided by the sensor. Refer to the section entitled “Other important FlowSonic settings” for more details.

Example: Set the bandwidth of the signal on the 4-20mA output to be limited to 25 Hz:

```
ILOOPFILTER 25
```

Command: TOTALMODE <n> <s>

Sets the operating mode for the totaliser, and the sense of the logic input. Refer to the section entitled “Configuring the Totaliser” for further details of the various modes.

<n> defines the mode as follows:

<n> value	Meaning
0	Count always / switch ignored
1	Count always / switch input resets
2	Count while active / reset
3	Count while active / no reset

<s> defines the sense of the logic input as follows:

<s> value	Meaning
0	Active when closed / low (input grounded)
1	Active when open / high (input not grounded)

Example: Set the totaliser to count continuously while the logic input is grounded, and to reset to zero as soon as the logic input is disconnected

```
TOTALMODE 1 1
```

Command: TR

Resets the totaliser to zero.

Example: Zero the totaliser

```
TR
```

Command: TTLMODE <n>

Controls the function of the TTL pulse output. Set the value of <n> to select a mode as follows:

<n> value	Meaning
0	TTL pulse output is disabled
1	TTL pulse output indicates mass flow rate
2	TTL pulse output indicates volumetric flow rate

Example: Set the TTL output to indicate mass flow

```
TTLMODE 1
```

Command: TTLSCALE <n>

Sets the number of pulses per unit of fluid which will be generated by the TTL interface.

<n> is the number of pulses per gram for mass flow, or the number of pulses per ml for volumetric flow.

Example: Set the TTL output to generate 1000 pulses per gram of fluid (assuming the TTL interface has already been set to indicate mass flow)

```
TTLSCALE 1000
```

Command: TTLFILTER <n>

Sets the time constant of the filter which will be applied to the flow rate indicated by the TTL interface.

<n> is in seconds. Set n = 0 to disable the filter. The maximum permitted value is 99 seconds.

Example: Apply a 10 second moving-average filter to the flow rate indicated via the TTL interface

```
TTLFILTER 10
```

Command: VOUTMODE <n>

Controls the function of the 0-10V analogue voltage output. Set the value of <n> to select a mode as follows:

<n> value	Meaning
0	Voltage output is disabled and delivers zero current
1	Voltage output indicates mass flow rate
2	Voltage output indicates volumetric flow rate

Example: Set the voltage output to indicate mass flow

```
VOUTMODE 1
```

Command: VOUTMAP <p> <f> <v>

Sets the straight line relationship between measured flow rate and the voltage output on the 0-10V analogue interface. The relationship is a straight line defined by two reference points.

The parameters are as follows:

Parameter	Function	Unit
<p>	Determines which reference point is being set Set p=0 to program the lower reference point Set p=1 to program the upper reference point	Index
<f>	Flow rate at the reference point	g/min (for mass flow) ml/min (for volume flow)
<v>	Voltage at the reference point	mV

Example: Set the voltage output to span a range from 0 to 1000 g/min mass flow between voltages of 0.5V and 4.5V respectively

```
VOUTMAP 0 0 500
VOUTMAP 1 1000 4500
```

Command: VOUTLIMIT <p> <v>

Sets the hard lower and upper limits on the voltage produced by the 0-10V interface.

The parameters are as follows:

Parameter	Function	Unit
<p>	Determines which reference point is being set Set p=0 to program the lower limit Set p=1 to program the upper limit	Index
<v>	Voltage limit value	mV

Example: Constrain the 0-10V interface to a maximum of 5V

```
VOUTLIMIT 0 0
VOUTLIMIT 1 5000
```

Command: VOUTERR <v>

Sets the voltage which will be generated by the 0-10V interface under conditions where the flow rate cannot be measured. This may, for example, be because it is programmed to

indicate mass flow making use of an external density meter, but the density meter is switched off.

The parameter <v> is in units of mV.

Example: Set the voltage under error conditions to be 0.25V

```
VOUTERR 250
```

Command: VOUTFILTER <b>

Sets the bandwidth of the digital low pass filter applied to the 0-10V interface.

Note, the maximum bandwidth actually available cannot exceed the bandwidth of the flow data provided by the sensor. Refer to the section entitled “Other important FlowSonic settings” for more details.

Example: Set the bandwidth of the signal on the voltage output to be limited to 10 Hz:

```
VOUTFILTER 10
```

Command: VER

Displays the version number of the firmware in the FCM.

Example: Display the firmware version

```
VER
F/w version 0.02 3 Feb 2017
```

Appendix C: Density meter data format

The FCM expects to receive regular messages from the density meter via the RS232 interface which conform to the format of this example:

```
T=  34.62 <C> D= 0.8417 <g/ccm>
```

- The temperature field is optional. If present, it must be in °C
- Temperature values may optionally be preceded by a '+' or '-' as applicable
- Density must be in g per ml
- Units must be encased in triangular brackets <>, however, the characters between these brackets are ignored
- Spaces are ignored
- Messages must be terminated by a carriage return (0x0D) and/or line feed (0x0A) character(s)

Messages may be transmitted at arbitrary intervals; once per second is typical.

If no message is received for more than 5 seconds, the FCM will assume the density meter has failed, and will report an error.