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F-OEM

Modular Pressure & Flow controller

FLUIGENT

CONTENTS

INTRODUTION

Our F-OEM offers our highest performance, efficiency, and widest pressure and flow rate ranges to support the most demanding industrial applications, including microfluidic and nanofluidic applications.

It is a standalone, modular platform that will perform complex fluidic operations. The platform allows one to choose the number of pressure modules, valve modules, and flow sensors.
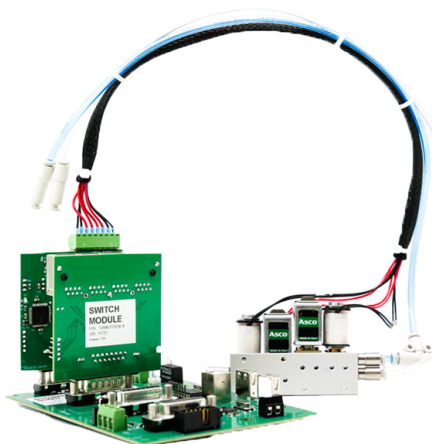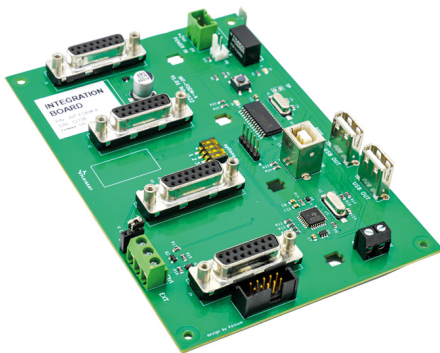

The F-OEM consists of a main platform – the integration board – that supports up to 8 modules: pressure modules (different ranges, push-pull), switch and electrovalve modules (for valve integration).

P/N: INT-FOEM-4 / INT-FOEM-EXT-X

INTEGRATION BOARD

Precaution: Do not plug/unplug the modules or touch the switches while the system is powered on. It can cause the system to work unstably. Moreover, the options on the option switch are only used at system start.
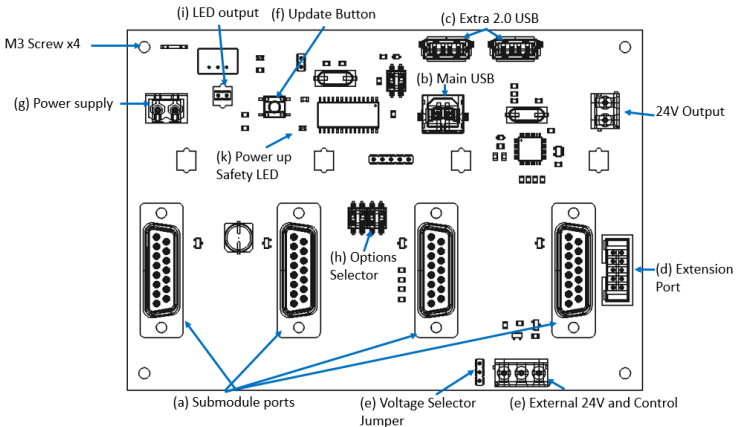
The switches labelled prog should never be changed positions, as it can cause the system to work unstably. If so, please contact the support for further guidance.

The integration board is the main platform that supports the F-OEM modules. The schematic below shows the main components of the board.

The board consists of the following elements:

a	**4 submodules ports** (DB15 connectors) to welcome pressure and switch modules
b	**Main USB port** for PC connection and Fluigent software use (RS-232 version on demand)
c	**Hub for managing 2 USB 2.0 devices** Full speed 12 Mb/s | Low-speed: 1.5 Mb/s
d	**Extension board port** extends up to 8 modules
e	**External 24V and control** or 5V, depending on the jumper's position on voltage selector
f	**Update button**
g	**Power supply port** to connect a 2-pin terminal block + wires (provided in connectors & tubing kit)
h	**Options selector** 1: default external control state | 2: default LED state (both at system start)
i	**LED output** to connect a LED
k	**Power up safety LED**

If additional submodule ports are required, it is possible to connect an extension board (from 1 to 4 additional submodules port) to the main module.
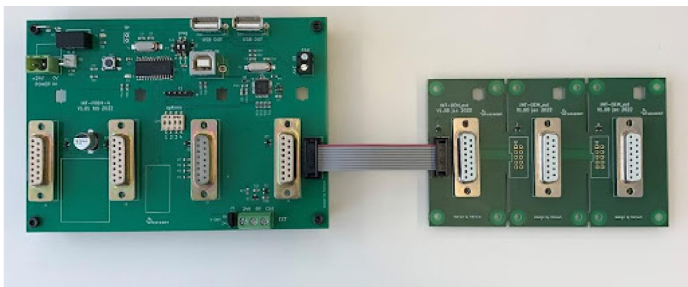
P/N: PRM-FOEM-XXXX

Pressure modules

The pressure modules consist of pneumatic and electronical sub-modules.

a. Pneumatic sub-module

The pneumatic sub-module consists of a manifold and pneumatic valve. Pressure supply and output are connected using 4 mm OD pneumatic tubing.

Different types of pressure modules depending on the pressure ranges are available. One can mix together different pressure ranges (see pressure range adapt part).
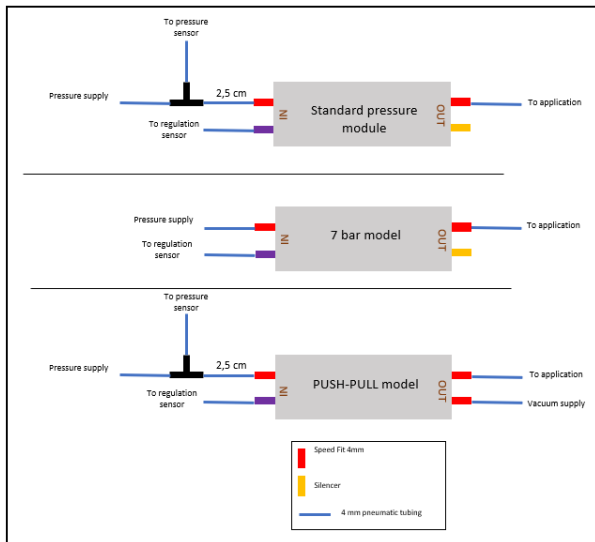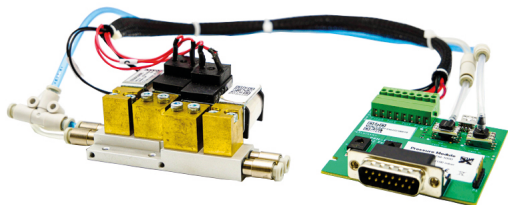
WARNING
When using the Push-Pull module, the module must always be supplied with pressure AND vacuum to operate correctly.

Braided PET Cable Sleeve, electrical wires (50 cm)

Terminal block (connected to pressure electronic submodule

4 mm pneumatic tubing (55 cm)
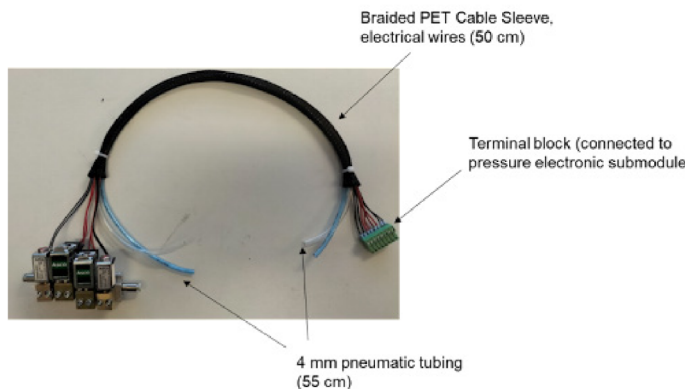
Control range	Required pressure supply range
7000 mbar	7100 mbar
2000 mbar	2100 mbar
1000 mbar	1100 mbar
345 mbar	
69 mbar	150 mbar
25 mbar	
-25 mbar	-800 mbar
-69 mbar	
-345 mbar	
-800 mbar	

a. Electronical submodule

The electronical submodule consists of the input and output pressure sensors (connected to the pneumatic sub-module), and the flow sensor port to support Fluigent flow sensors. A flow sensor can directly be connected to the pressure module. Flow sensor range: from 0 - 1.5 μL/min to 0 - 5 mL/min (see our flow sensor offer). Dedicated screws for screwing to the integration board are included.

Flow Sensor port

Input Pressure Sensor

Output Pressure Sensor

Connection Port
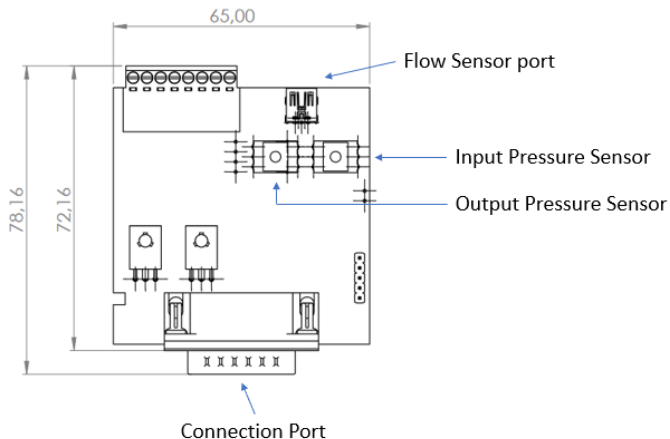
P/N: SWM-FOEM-4

Switch modules
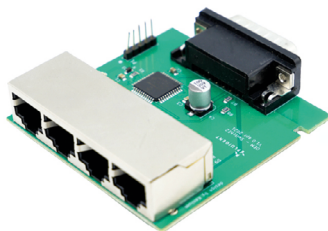
The switch module can be directly connected to the Integration board. It consists of 4xRJ45 ports, allowing to control up to 4 valves. It can for instance control the following valves:

- **Fluigent 2-X:** 3-port/2-way microfluidic valve

- **Fluigent M-X:** 11-port / 10-way microfluidic valve for injection or selection of up to 10 different fluids.

- **Fluigent L-X:** 6-port/2 position microfluidic valve. It is designed for precise sample injection or fluid recirculation in cell culture applications.

P/N: MEV-FOEM-4

ELECTROVALVE MODULES

The F-OEM electrovalve control module was developed for connecting and actuating up to 8 x 3/2 electrovalves per module.

This valve system efficiently manages multiple pressure using one or two pressure controllers.

It can be used to control the state of the devices, with ON/OFF states with 0-24V with 3-Watts power consumptions

(A peak current of 500mA during a brief 100ms period).

P/N: FOEM-CTQ-KIT01

CONNECTORS & TUBING KIT

Cables and pneumatic tubing and connectors to start experiments. Consists of the following elements: USB Cable 1.8m (x1) 4mm pneumatic tubing (4m), 6mm pneumatic tubing (3m), double Y manifold 1x 6 mm to 4x 4 mm (x1), 4 mm red plug (x4).

SUMMARY

F-OEM components	
Integration board [INT-FOEM-4]	Main electronic board. 4 slots for pressure or switch modules. Extension slots available (INT-FOEM-EXT-X)
Pressure modules [PRM-FOEM-XXXX]	Pressure: 25 mbar (0.36 psi) / 69 mbar (0.9 psi) / 345 mbar (5 psi) / 1000 mbar (14.5 psi) / 2000 mbar (29 psi) / 7000 mbar (101 psi)
	Vacuum: -25 mbar (-0.36 psi) / -69 mbar (-0.9 psi) / -345 mbar (-5 psi) / -800 mbar (11.6 psi)
	"Push-Pull" pressure & vacuum module: -800 mbar (-11.6 psi) to 1000 mbar (14.5 psi)
	Pressure regulator [PRG-FOEM] if modules with different pressure supply is needed
Switch modules [SWM-FOEM-4]	F-OEM Switch control 4 x RJ45 ports
(Optional) Connectors & tubing kit [FOEM-CTQ-KIT01]	USB Cable 1.8m (x1) 4mm pneumatic tubing (4m), 6mm pneumatic tubing (3m), double Y manifold 1x 6 mm to 4x 4 mm (x1), 4 mm red plug (x4)
Electrovalves Modules [MEV-FOEM-4]	F-OEM electrovalve control module for actuating up to 8 x 3/2 electrovalves

SETTING UP

Precaution: Peripherals/submodules should never be plugged or unplugged while the system is powered on. This could result in malfunctions or system failures. Power supply is the last step of the set-up.

PRESSURE MODULES CONNECTION

1. Connecting the pressure module to the integration board

To connect the pressure module to the integration board, simply connect the electronic sub-module to the DB15 ports of the integration board (see picture below). Srew the module to the board.
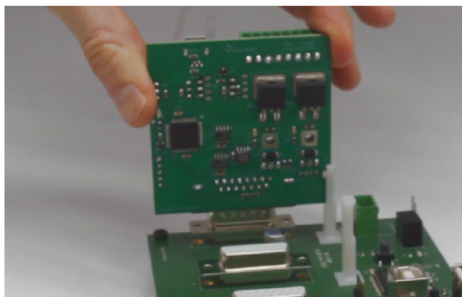
NOTE: make sure that the main board is powered off when plugging or unplugging submodules, as it could result in malfunctions.

2. Pressure inputs and outputs

Connect the pressure inlet and outlet using 4 mm pneumatic tubing. For the Push-Pull model, connect your vacuum supply with the additional 4 mm speed-fit dedicated to the vacuum.

> **WARNING**
> **When using the Push-Pull module, the module must always be supplied with pressure AND vacuum to operate correctly.**

a. Connect one pressure source to several pressure modules

If using several pressure modules, one can connect them together using a manifold (we can provide you manifolds with different types of connection if required, contact us).
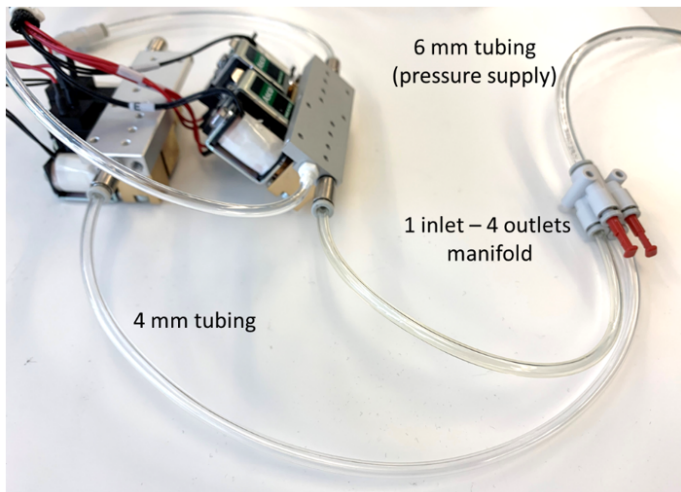
b. Using different pressure supply ranges

If one mixes pressure modules with different working input pressure (e.g., mixing a 0 – 69 mbar pressure module that requires 150 mbar pressure input, and a 0 – 2000 mbar pressure module that requires 2100 mbar pressure input), one can use a pressure regulator.

Fluigent can provide a pressure regulator with suitable fittings if necessary (reference: **PRG-FOEM**).
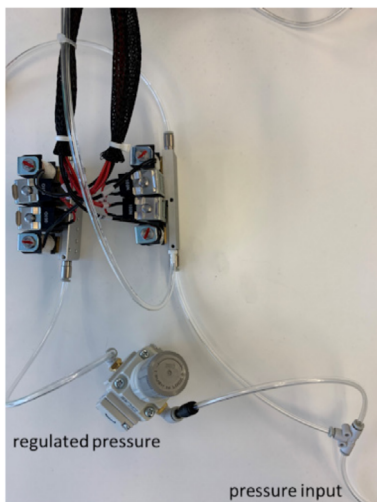
regulated pressure

pressure input

Control range	Required pressure supply range
7000 mbar	7100 mbar
2000 mbar	2100 mbar
1000 mbar	1100 mbar
345 mbar	
69 mbar	150 mbar
25 mbar	
-25 mbar	-800 mbar
-69 mbar	
-345 mbar	
-800 mbar	

3. Connecting Fluigent flow sensors

To connect the pressure module to the integration board, simply connect the electronic sub-module to the DB15 ports of the integration board (see picture below).

> **Note:** We recommend to plug or unplug anything ONLY when the main board is powered off. Not doing so could damage the equipment or result in malfunctions.

flow sensor

electrical sub-module
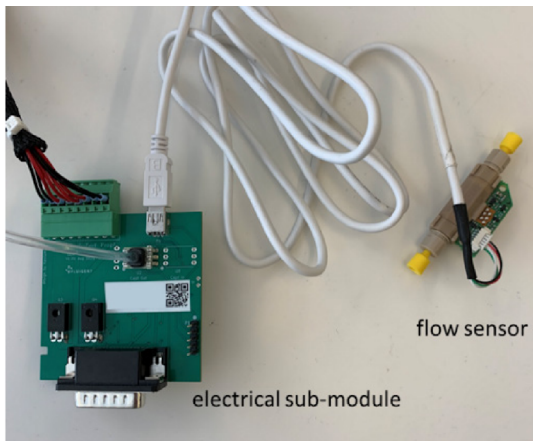
4. Connecting third party sensors

Third party sensors can be connected using the USB 2.0 ports of the F-OEM.

Switch modules connection

> To connect the switch module to the integration board, simply connect the module to the DB15 ports of the integration board (see picture below).
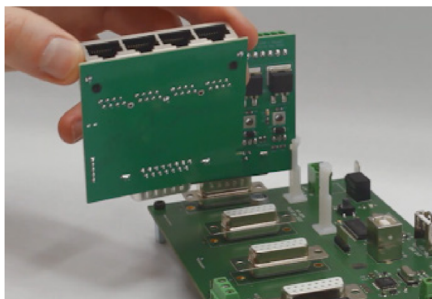
Note: always plug or unplug submodules while the main board is powered off.

Connecting Fluigent microfluidic valves

If one wants to use microfluidic valves with the F-OEM, simply connect the microfluidic valve directly to the F-OEM Switch module using the RJ-45 cable of the valve. The system will automatically be detected by our software (SDK and Oxygen)

Electrovalve module connection

To connect the electrovalve module to the integration board, simply connect the module to the DB15 ports of the integration board.
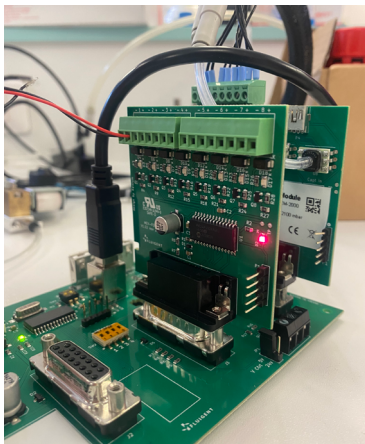
Note: always plug or unplug sub-modules while the main board is powered off.

Connecting external devices

To use electrovalves or other external systems with the F-OEM electro-valve module, connect the devices to the F-OEM module using 0 and 24 V electrical wires. The 0 and 24 V states can be actuated through Fluigent Oxy GEN software and SDK.

Digital controlled output (5V or 24V)

> **NOTE:** these are digital outputs, which means they only control ON and OFF states. Always use the same group connector points.
>
> To use the following functions, report to the appropriate section in the Fluigent **Software Development Kit user manual**.

The two digital outputs available are mainly to serve two purposes:

Ext. is designed to control a 2 or 3 wire system (e.g., small pump, 24V valve with power draw, …) using a main power feeding and a control voltage.

The main power is 24V, whereas the control can be 24 or 5V.

It is selected using the small jumper labelled "V ctrl" next to the terminal block. Its default state can be changed using the first switch of the 4way switch labelled "options". Note that the 5V is current limited

P8: Control an external LED. This port is 0-5V and 5 mA

USB Peripherals & others

> The FOEM platform is equipped with a 2.0 USB Hub that can handle 2 additional peripherals, which will then be bundled along with the FOEM's USB. There is no recognition by the FOEM as it only passes the information through.

For setting up regulation with Third party sensors, please refer to the appropriate section in the SDK manual.

The FAN labelled output is a constant 24V output. It cannot be turned off.

RS232 COMMANDS

1. RS232 Interface

The RS-232 interface is a 9-pin D-Sub socket used for remote communication. The voltage level is ±10 V (pin 5: GND; pin 2: RX +-10V; pin 3: TX +- 10V).

2. RS232 Interface Settings for the Serial parameters

Serial Communication parameters should be set as follows:

Baud Rate	Default value: 115200 bps Can be modified with corresponding command
Data Bits	8
Stop Bits	1
Parity	No parity
Flow Control	None

3. Remote Request and Command set

This remote command set is the default set available on the instrument. All commands must be terminated with a <CR>. All decimal values use the point "." as decimal separator.

It is recommended to send a single carriage return character <CR> before sending the first command to the instrument, to ensure that the buffer is empty. Make sure your serial communication software does not add line feed or flow control characters, as the instrument will not be able to parse them and will consider the command invalid.

A query command ends with a question mark "?" for queries. The data column represents the response of the instrument. All response strings are terminated with a <CR>. Any response containing multiple values will have the values separated by commas ",", without spaces.

For all commands (no question mark "?"), the data column represents the required parameters to be sent to the instrument following the string in the command column. Any command that requires multiple parameters must have the parameters separated by commas ",". In case of error in the command spelling, the command is ignored by the instrument and no error code is returned.

Requests

All requests and answers finish with <CR>.

General Requests

Command/Query	Answer	Comments	Examples
<CR>		Send a single carriage return character to flush the instrument's serial communication buffer	
INT:IDN?	<vendor>, <instrument>,<no série>,<no version>	Decimal numbers on 5 characters	FLUIGENT, INTFOEM,00001,00205
INT:STATUS?	<status>	bit0 = pump state : 1=ON bit1 = remote LED status 1=ON bit7 = general state : 0=starting 1=running	81 (run and pump on)
INT:X:IDN?	<vendor>, <instrument>,<no série>,<no version>	X = 1 to 8, number of FOEM channel Decimal number on 5 characters	FLUIGENT,PRM, 00123,00205 **FLUIGENT,SWM, 00101,00100**
INT:X:STATUS	<vendor>, <instrument>, <status>	X = 1 to 8, number of FOEM channel all modules: bit0 = 1 if normal If PRM : bit 1 = 1 if Under pressure, bit 2 = 1 if Over pressure, bit 4 = 1 if DFC error, bit 5 = 1 if air detected on flow sensor If no module : "ERROR NO MODULE"	FLUIGENT,PRM ,01

Pressure Module (PRM) Requests

Command/Query	Answer	Comments	Examples
PRM:X:CONF:P?	<pmin>, <pmax>, <mode>	X = 1 to 8, Number of FOEM channel If PRM: pmin = in mbar, no decimal pmax = in mbar, no decimal mode: 0 = Fast, 1 = Smooth If no PRM: "ERROR NO MODULE"	0, 1000, 0 (PRM 1 bar, fast) -800, 100, 1 (Push pull, smooth)
PRM:X:CONF:Q?	<qmin>, <qmax>, <qtable>	X = 1 to 8, Number of FOEM channel If PRM with connected flow unit qmin = in µl/min, 2 decimals, separator '.' qmax = in µl/min, 2 decimals, separator '.' Qtable: 0 = H20, 1 = IPA, 2 = HFE, 3 = FC40, 4 = OIL If no PRM: "ERROR NO MODULE" If no sensor : "ERROR NO Q SENSOR"	-5500.00, 5500.00, 0 (XL, H2O) -200.00, 200.00, 3 (M, FC40)
PRM:X:MEAS:PIN?	<pmeasure>	If PRM : entry pressure pmeasure = in mbar, 2 decimals, separator '.' If no PRM: "ERROR NO MODULE" If no sensor: "ERROR NO INLET SENSOR"	543.21
INT:X:IDN?	<vendor>, <instrument>,<no série>,<no version>	X = 1 to 8, number of FOEM channel Decimal number on 5 characters	FLUIGENT,PRM, 00123,00205 **FLUIGENT,SWM, 00101,00100**

Command/Query	Answer	Comments	Examples
PRM:X:MEAS:P?	<pmeasure>	If PRM pmeasure = in mbar, 2 decimals, separator '.' If no PRM: "ERROR NO MODULE"	543.21
PRM:X:MEAS:Q?	<qmeasure>	If PRM with connected flow unit qmeasure = in µl/min, 2 decimals, separator '.' If no PRM: "ERROR NO MODULE" If no sensor : "ERROR NO Q SENSOR"	123.45
PRM:X:MEAS:T?	<tmeasure>	If PRM with connected flow unit tmeasure = in degrees centigrades, 1 decimal, separator '.' If no PRM: "ERROR NO MODULE" If no sensor: "ERROR NO Q SENSOR"	25.6
PRM:MEAS:ALL:P?	<pmeasure 1>,...,<pmeasure n>	As many values as connected PRMs If no PRM : "ERROR NO MODULE"	500.23,12.45,555,12
PRM:MEAS:ALL:Q?	<qmeasure 1>,...,<qmeasure m>	As many values as connected PRMs If no PRM : "ERROR NO MODULE" If no sensor : "ERROR NO Q SENSOR"	7.5, 12.6

Switch Module (SWM) Requests

Command/Query	Answer	Comments	Examples
SWM:X:READ:Y?	<type>, <pos>	X = 1 to 8, Number of FOEM channel Y = 1 to 4, Valve location If SWM: type = "2SW", "MSW", "LSW" or "N/C" pos = if 2SW : "OFF","ON", if MSW : "1" à "10", if LSW : "1" ou "2", if N/C : "N/C" (not connected) If no SWM : "ERROR NO MODULE"	2SW,ON MSW,6 N/C,N/C

Electrovalves Module (EVM) Requests

Command/Query	Answer	Comments	Examples
MEV:X:READ?	<pos>	X = 1 to 8, FOEM channel number If MEV pos = "YY" if valve on: bit=1 if valve off; bit=0 If no MEV: "ERROR NO MODULE".	01: valve 1 ON 00: all valves OFF FF: all valves ON 80: valve 8 ON

All commands finish with <CR>. No answer sent. If the command is incorrect, it is ignored.

General Commands

Command/Query	Comments	Examples
INT:A9B4:<value>	Stores serial number (4 hexadecimal characters)	INT:A9B4:12AB
INT:SETBR:<value>	Changes baudrate : 0=9600, 1=19200, 2=38400, 3=57600, 4=115200	INT:SETBR:1
INT: PUMP:<value>	Commands pump : 0=OFF, 1=ON	INT:PUMP:1
INT:LED:<value>	Commands remote LED : 0=OFF, 1=ON	INT:LED:1
INT:X:STATUS	X = 1 to 8, number of FOEM channel all modules: bit0 = 1 if normal If PRM : bit 1 = 1 if Under pressure, bit 2 = 1 if Over pressure, bit 4 = 1 if DFC error, bit 5 = 1 if air detected on flow sensor If no module : "ERROR NO MODULE"	FLUIGENT,PRM ,01

Pressure Module (PRM) Commands

X represents PRM position.

Command/Query	Comments	Examples
PRM:X:P:<value>	Pcmd in mbar	PRM:1:P:125.89
PRM:X:Q:<value>	Qcmd in µl/min	PRM:4:Q:99.00
PRM:X:MODE:<value>	Mode change (fast/smooth)	PRM:1:MODE:0
PRM:X: EVO|EVI:ON|FF	Manual control of EVs (ON/OFF valves) Active only if PRM is in "IDLE" mode, i.e. if no regulation is in progress	PRM:2:EVI:ON PRM:4:EVO:OFF
PRM:X:EPI|EPO:<value>	Manual control of entry valve or leakage 0000 to FFFF value (0 to 100%) Active only if PRM is in "IDLE" mode, i.e. if no regulation is in progress	PRM:2:EPI:AAAA
PRM:X:ZERO	Calibration at atmospheric pressure	
PRM:X:SCALE:<value>	Forces calibration table of flow sensor Value from 0 to 4	PRM:X:SCALE:3

Switch Module (SWM) Commands

Command/Query	Comments	Examples
SWM:X:SET:Y:<value>	Y : 1 to 4 : pilot valve <**value**> : "ON", "OFF" or "1" to "10"	SWM:1:SET:2:ON SWM:1:SET:4:5
SWM:X:CCW:Y:<value>	Y : 1 to 4 : pilot valve <**value**> : "1" to "10"	SWM:1:CCW:4:5
SWM:X:CW:Y:<value>	Y : 1 to 4 : pilot valve <**value**> : "1" to "10"	SWM:1:CW:4:5
PRM:X: EVO|EVI:ON|FF	Manual control of EVs (ON/OFF valves) Active only if PRM is in "IDLE" mode, i.e. if no regulation is in progress	PRM:2:EVI:ON PRM:4:EVO:OFF
PRM:X:EPI|EPO:<valeur>	Manual control of entry valve or leakage 0000 to FFFF Value (0 to 100%) Active only if PRM is in "IDLE" mode, i.e. if no regulation is in progress	PRM:2:EPI:AAAA
PRM:X:ZERO	Calibration at atmospheric pressure	
PRM:X:SCALE:<valeur>	Forces calibration table of flow sensor Value from 0 to 4	PRM:X:SCALE:3

Electrovalves Module (MEV) Commands

X represents MEV position.

Command/Query	Comments	Examples
MEV:X:SET:<mask>:<value>	<mask> : ZZ (hex code from 00 to FF) if valve to control :bit=1 if valve not to change : bit = 0 <value> : YY (hexadecimal code from 00 to FF) if valve to activate : x=1 if valve to deactivate ; x=0	MEV:3:SET:FF;AA MEV:3:SET:FF;01
MEV:X:INVERT:<mask>	reverses all masked valves <mask>: ZZ (Hexadecimal code from 00 to FF) if valve to be controlled: bit=1 if valve not to be changed: bit=0	MEV:3:INVERT:FF MEV:3:INVERT:55

Power supply

Connect your power supply to a 2-pin PCB terminal block, which is connected to the power supply port of the F-OEM integration board (a terminal block and the red/blue electrical wires can be provided separately in the prototyping kit). The LED between the second submodule port and the button (indicated as (k) on the scheme of the INT-FOEM) should blink 3 times (indicating the system is correctly started up. If not, disconnect the power supply right away and contact the support).

> **NOTE:** peripherals/submodules should never be plugged or unplugged while the system is powered on. This could result in malfunctions or system failures.
>
> **Attention:** It is crucial to ensure the proper connection of the power wires to the INT-FOEM board to prevent damage or malfunction of the device. Please carefully confirm that the 24V power wire is connected to the 24V terminal and the ground power wire is connected to the GND terminal as indicated on the INT-FOEM board. Incorrect connections can lead to severe damage or failure of the device.

```
+24    0V
Power IN
```

SOFTWARE

SDK (SOFTWARE DEVELOPMENT KIT)

The F-OEM is fully supported by Fluigent SDK. It has been ported to the most popular programming language within the instrumentation field (LabVIEW, C++, C# .NET, Python and MATLAB). This SDK merge all Fluigent pressure controllers and sensor instruments and provide an advanced regulation loop. A specific function has been implemented for the F-OEM, which allows to set a digital output ON or OFF on a controller:

fgt_set_digitalOutput : see page 42 of the SDK user manual

For all the functions and the user manual, visit the following webpage: https://github.com/Fluigent/fgt-SDK

OxyGEN

Fluigent OxyGEN software supports the F-OEM and its submodules. The F-OEM will be identified and the same level of features of our end-user products is available.

For more information, visit OxyGEN webpage available here: https://www.fluigent.com/research/software-solutions/oxygen/

SPECIFICATIONS

Fluigent OxyGEN software supports the F-OEM and its submodules. The F-OEM will be identified and the same level of features of our end-user products is available. For more information, visit OxyGEN webpage available here:

https://www.fluigent.com/research/software-solutions/oxygen/

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