Owlstone ultraFAIMS-MS Development Kit:
Developer Guidance Notes

Contents

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Notice of Proper Use of Owlstone Ltd Instruments

The supplied system is in compliance with international regulations. If this system is used in a manner not specified by Owlstone Ltd, the protection provided by the system could be impaired

Safety notice

Always observe the following safety precautions

- Use only the mains adaptor and leads supplied.
- This equipment is for use in moderate climates only. Do not use the equipment in damp or wet conditions.
- Avoid excessive heat, humidity, dust & vibration.
- Do not use where the equipment may be subjected to dripping or splashing liquids.

Ensure the system is properly installed on the mass spectrometer according to the enclosed instructions before attempting to power on. Never operate the system unless properly installed on the mass spectrometer.

Ensure the safety earth cable is connected to a suitable earth point on the mass spectrometer chassis before powering on and operating the system.

Do not operate the system without a chip module attached.

Caution: risk of electric shock. Remove power from system before disconnecting from the mass spectrometer. Do not remove cover without disconnecting system from 24V DC.

This equipment is mains rated 100-240VAC, 50-60Hz 120W max. It is fitted with a fuse of type F3.15AH 250VAC fast-acting. Replace only with a fuse of the same type and rating.

PLEASE READ THIS DOCUMENT <u>BEFORE</u> SETTING UP AND POWERING THE SYSTEM

Contacting OWLSTONE

Visit the OWLSTONE website (www.owlstonenanotech.com) for up to date contact details and service support

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System Description

This software interface is provided to control the Owlstone ultraFAIMS-MS system. The ultraFAIMS-MS system is a field-asymmetric waveform ion mobility (FAIMS) pre-separator intended for use on suitably modified Mass Spectrometers only.

The system can be used to separate or filter ions before they enter the mass spectrometer. This may provide a reduction in chemical noise or allow observation of ions that would otherwise be difficult to resolve on the mass spectrum.

The Developer Kit is a variant of the standard ultraFAIMS system that is supplied to developers who wish to customize the system for use on a Mass Spectrometer for which an Owlstone interface is not yet available. These notes are provided to assist with understanding how to use the system and how to develop a custom interface. However, ultimate responsibility for safety of the customized system lies with the developer.

System Familiarization

The system consists of the following items:

1. UltraFAIMS control unit
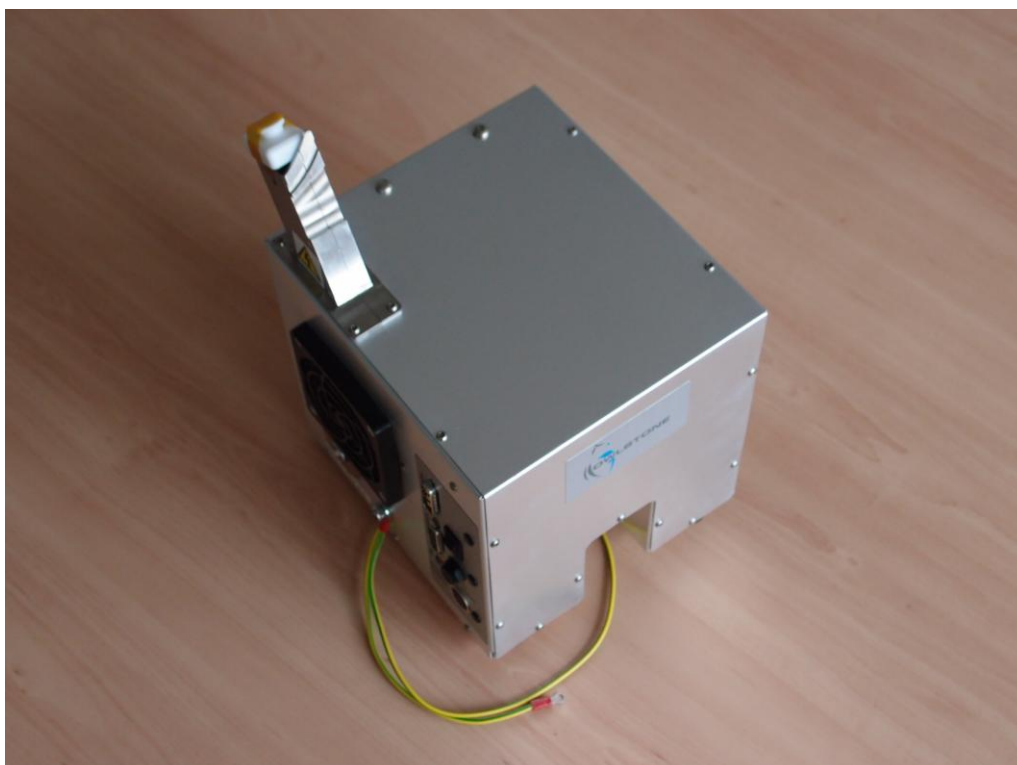
The control unit provides communication with a PC and generates the FAIMS waveforms needed to drive the FAIMS chip.

2. Chip module

The chip module holds the FAIMS chip and connects to the DF feeder port on the top of the control unit.

3. Power supply and mains lead

4. Door lock override

5. Reference voltage input cable

6. External trigger cable

Information on how to use the external trigger cable is available on the Owlstone support website.

7. Chip module pliers

These can be used to help detach chip module from DF feeder

Safety Considerations for Developers

FAIMS voltages can be hazardous. When designing a custom interface you should consider how to ensure that live parts of the system are not accessible during operation.

What parts of the system can be hazardous live?
When a FAIMS sweep is underway and the chip module is connected to the DF feeder, the chip (accessible through the module inlet aperture) and the metal cap on the front of the chip module are hazardous live.

Chip module cap

Inlet aperture
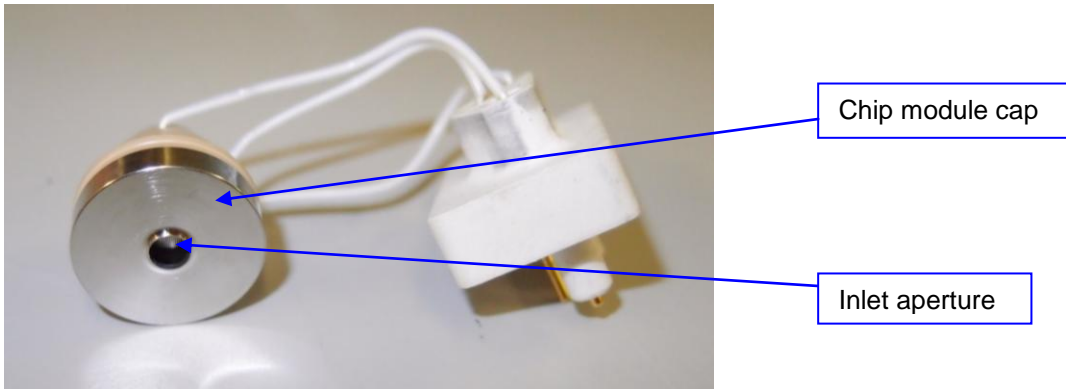
The chip carries AC voltages of up to 330V AC at 27.12MHz plus a possible DC offset of up to +/-100V. The metal cap carries only the DC offset.
All these voltages are referenced to a floating ground voltage. The level of this floating ground voltage is determined by the voltage supplied to the HV input connector.

HV input connector

DF feeder connector
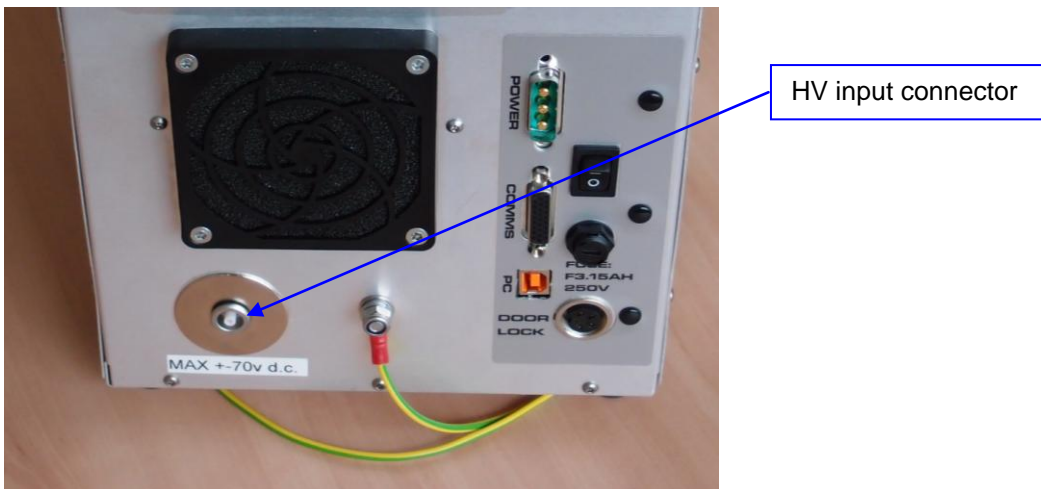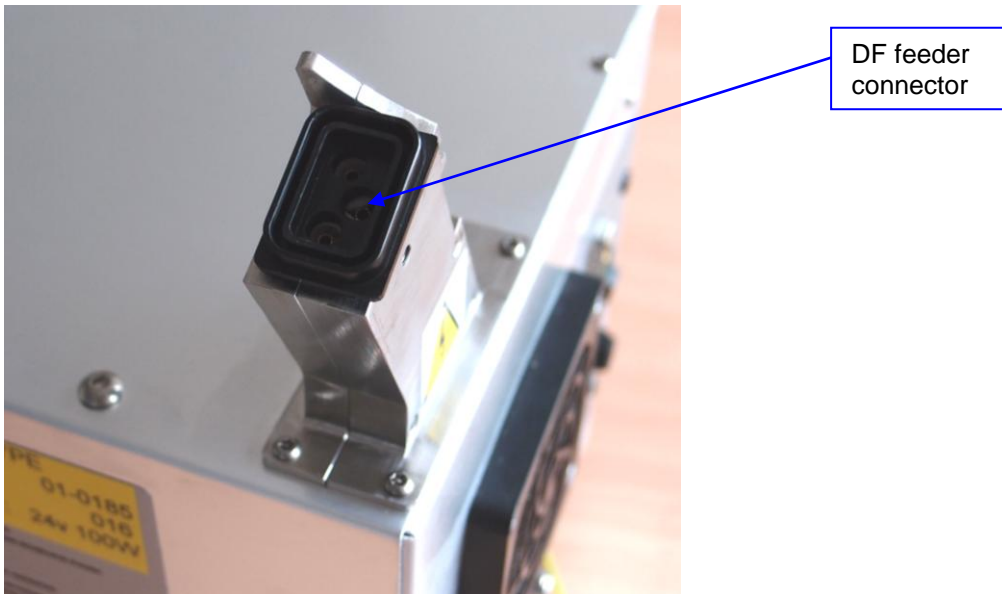
A ground reference input cable is supplied. The bare end should be connected to a suitable reference voltage supply. A ground reference of up to +/-6000V can be used, but if a voltage above +/-70V is supplied, be aware that hazardous voltages may become accessible on the pins of the DF feeder when the chip module is not connected.

Please note: this input voltage should be supplied, even if the required reference voltage is 0V.

Are the live voltages on the chip and chip module cap accessible?
This will depend entirely on how you design your mounting interface for the chip module. We recommend that you consult safety standard IEC61010-1 for detailed information on how to prevent hazardous live voltages from being accessible.

Mechanical drawings of the chip module itself are available on the Owlstone support website (http://support.owlstonenanotech.com/categories/20097286-UltraFAIMS-MS-Development-Kit) to aid with confirming dimensions.

Hazardous voltages are NOT accessible at the DF feeder connector end of the chip module, provided you do not tamper with the potting around the white wires.

Can we use an interlock?
An interlock input is available (labelled Door Lock). The door interlock is a dual redundant circuit that will disconnect the 24V DC supply to the parts of the system that internally generate the hazardous live voltages.

If you do not wish to use an interlock, connect the door lock override connector to this input.

Door lock override connector
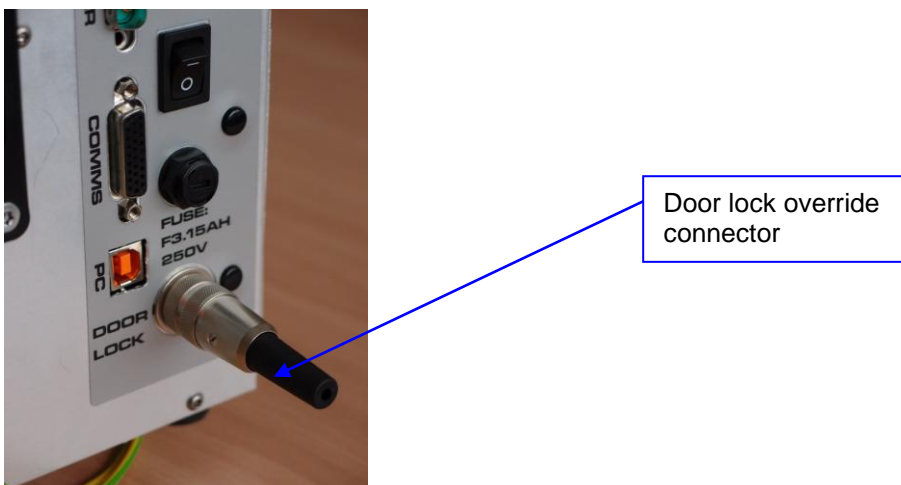
If you do want to make use of the interlock input, see the cable wiring diagram on the Owlstone support website http://support.owlstonenanotech.com/categories/20097286-UltraFAIMS-MS-Development-Kit.

When the interlock input is disconnected, the control unit will remain powered and able to communicate with the PC, but all FAIMS voltages are disabled. Please note: the ground reference voltage will not be disabled and if present, will still be applied to the pins of the DF feeder and to the chip module (if connected). Consider whether it is necessary to apply a separate interlock to disable the ground reference input voltage when the chip module is accessed.

Safety earth
A safety earth cable is attached to the control unit. The other end of this cable must be connected to a suitable safety earth point on the Mass Spectrometer chassis using an M4 screw before the control unit is powered on.

Developing a custom chip interface

The most straightforward way to interface the chip module to a mass spectrometer is to extend the Mass Spectrometer inlet capillary in such a way that the chip module can slide onto it, such that carrier gas and ions are pulled through the chip into the mass spectrometer. See the chip module drawings on the Owlstone support website for dimensions.

The FAIMS chip provided in the Development Kit achieves optimum performance with a carrier gas flow of around 1.5-2l/min. At higher gas flow rates, separation performance will be reduced. At lower gas flow rates, ion transmission will be reduced.

Other considerations:

1. **Electric fields:** the chip and chip module cap are always at the same DC voltage. These can be offset relative to the ground reference input voltage by up to +/-100V. This voltage is controlled using the PC software interface provided - see software user manual. A distance of >=1mm is needed between the chip and any metal parts at the same bias voltage, to prevent breakdown due to the additional RF voltages applied to the chip during FAIMS sweeping.

2. **Desolvation of ions:** ions must be well desolvated before they reach the FAIMS chip. Consider where to place the chip relative to the ionisation source so that desolvation happens upstream of the chip. It may be advisable to use a heated counter flow of gas (opposing the flow into the chip module) to assist desolvation. WARNING: if the chip is exposed to liquid droplets while FAIMS voltages are applied, the chip and control unit may be damaged. We advise thorough testing to confirm desolvation before attempting FAIMS sweeps. If desolvation cannot be assured, please contact Owlstone via the support website for advice.

3. **Chip module temperature:** the chip module should not be exposed to sustained temperatures above 150°C or it may be damaged.

4. **Flow sealing:** it is important to ensure good sealing to ensure all carrier gas flow passes through the FAIMS chip and into the MS inlet. The rear aperture of the FAIMS chip module contains an o-ring to assist sealing.

5. **Chip mounting:** the existing chip module is designed to ensure minimum stresses are applied to the FAIMS chip when assembled into the housing (since this would risk distorting the gaps in the chip, which would affect performance). If you intend to remove the chip PCB from the chip module and use a different housing, consider how to ensure minimum distortion of the chip PCB.

6. **Chip cleanliness:** handle chips/chip modules carefully to avoid contamination and especially particulates entering the chip. Chips are physically robust, but any shorting across the gaps (100um width) caused by conductive debris is likely to damage the chip and control unit. If chemical contamination builds up during use, chip modules can be cleaned by sonicating in water and/or methanol/IPA. Ensure chips are completely dry after cleaning before they are used again.

7. **Connections to chip PCB:** if you decide to remove the chip PCB from the chip module, you will need to de-solder the white wires running from the DF feeder connector to the chip PCB. When reconnecting, the central wire (that runs from the apex of the triangle made by the 3 wires) must be connected to the central pad on the PCB (not connected to the chip). The other two wires connect to either side of the chip (it doesn't matter which way round). Note the springs on the front side of the PCB, which are used to bring the DC cap voltage to the metal chip module cap.

8. **Parasitic capacitances:** any significant change to the capacitance experienced by the FAIMS chip can affect the shape of the FAIMS separation waveforms. FAIMS performance is very sensitive to waveform shape. It is therefore important to try to avoid adding extra capacitance – e.g. due to any additional metalwork near to the chip or the wires in the chip module, or due to extending the length of the wires.

We strongly advise contacting Owlstone to request a design review for custom interface designs.

How to Set Up the System

Once you have your custom chip mounting interface ready to go, the system is set up as follows:

1. Install the PC interface software provided (see software user guide for more info)

2. Position the control unit suitably close to the MS inlet

3. Install your custom chip mounting interface on the MS and connect the DF feeder connector

4. Connect the safety earth cable to a suitable earth point on the MS chassis

5. Connect the ground reference input cable from your reference voltage supply to the control unit

6. Connect the USB cable from the PC to the control unit

7. Connect the power cable from the external power supply to the control unit and plug in the power supply.

8. If using the external trigger cable, connect this to the Comms connector port.

9. Connect the interlock override or an interlock cable, if you have made one.

Reminder: Do not operate the system without a chip module attached.

See *OW-003401-TM Owlstone ultraFAIMS-MS user interface software manual* (available on the Owlstone support website: http://support.owlstonenanotech.com/categories/20097286-UltraFAIMS-MS-Development-Kit) for instructions on how to operate the system using the PC software.

Connector panel