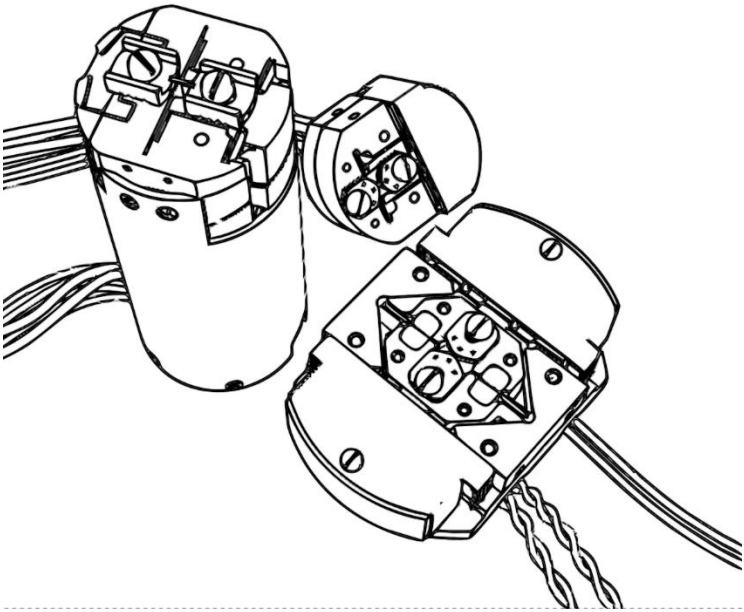
Quick Start Guide

Version for customers without a PPMS probe or kit



This short document gives a quick overview of how to get going quickly with your Razorbill Instruments Cryogenic strain cell.

Cell Basics

You have purchased a compact device for applying uniaxial pressure (stresses and strains) to samples at cryogenic temperature.

There are four main types of device, the CS1x0 series strain cells, the CS2x0T series strain cells, FC1x0 stress cells and the UC200 which supports both stress and strain.

- **The CS1x0 series** consists of the same titanium chassis, but different lengths of piezoelectric stacks and thus differing travel ranges. They are designated CS100 to CS130. These cells measure displacement, from which strain can be calculated
- T**he CS2x0T** series cells share a titanium chassis, with a wide access cone on the reverse, but utilise different lengths of stack. Like the CS1X0 series, these cells measure displacement, from which strain can be calculated.
- **The FC1x0** series have variations in their titanium flexure mechanisms that provide different design forces. Unlike the CS series, they measure force, from which stress can be calculated
- **The UC200** cell has only one version. It is capable of measuring force and displacement simultaneously. This allows stress and strain to be calculated.

All of these types of device are used inside a cryostat to apply uniaxial pressure to samples.

All four types of cell are driven by internal piezoelectric stacks. The cells use an arrangement of piezoelectric stacks consisting of a set of compression stacks and tension stacks. When the compression stacks have a positive electrical potential applied to them, the sample is compressed. When a positive electrical potential is applied to the tension stacks, the sample is tensioned. If both the tension and compression stacks have the same potential applied

to them, then there should be little, or no strain applied to the sample.

To measure the uniaxial pressure applied to the sample a capacitive sensor is built into the cell. The sensor consists of two parallel plates that have a gap between them that changes depending on the displacement applied to sample (CS and UC type cells) or the force applied to the sample (FC and UC type cells). This capacitance can be measured using a capacitance bridge and converted to the displacement or force using the capacitance curve provided in the accompanying documentation.

Wiring inside the cryostat

The strain cell drive wires are terminated with PEEK stepped

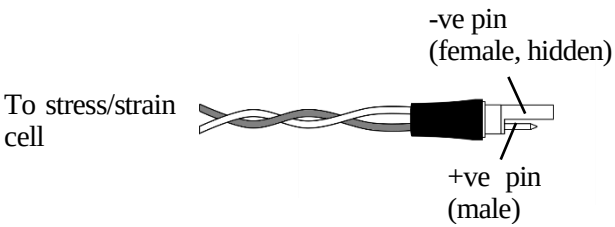


Figure 1: *A LEMO FGG.0S.302.ZLAT connector indicating polarity. Note that as this is a hermaphrodite connector, the one on the cryostat cable will have the opposite polarity.*

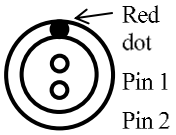
connector, LEMO FGG.0S.302.ZLAT. The colour of the wires will indicate with it corresponds to the tension or compression stacks – red/white indicates the tension stacks and blue/brown the compression stacks. Mating connectors are provided with each cell to be added to the drive wiring in your cryostat. Ensure you do not exceed the (temperature dependent) maximum voltages and ensure that the polarity is correct. Too large, or excessive negative voltages could instantly damage your strain cell! For more details on allowable voltages and wiring schemes that

require fewer channels and/or fewer feedthroughs please see Application note AP002, *Drive Electronics* and the relevant datasheet for your product.

The two coaxial wires are terminated with female MMCX connectors. The male MMCX mating connectors are provided with your cell to be used with your coaxial wiring in your cryostat.

Wiring outside the cryostat

If you purchased an RP100 power supply Razorbill Instruments will also have supplied cables. These are terminated at both ends with Lemo 0B.302 series plugs and are suitable for LEMO_HGG.0B.302.CLLPV vacuum feedthroughs. If you decide to replace the connectors to suit different feedthroughs, please ensure they are suitable for 200 Volts and do not present a risk of electric shock if inadvertently energised when disconnected.



LEMO HGG.0B.302.CLLPV. Mates with any LEMO 0B.302 series plug.

Figure 2: *LEMO connector on the front panel of an RP100 power supply or LEMO_HGG.0B.302.CLLPV vacuum feedthrough. Pin 1 is -ve, pin 2 is +ve.*

The RP100 is primarily designed to be used as part of an automated experiment using text commands sent over USB, generated using a script (See RP100 manual). Razorbill Instruments offers a simple software tool to help you get started using the serial commands. It can be downloaded from our website.

The cables from the capacitors should be connected to your capacitance meter or LCR. The two cables have a section of coloured heatshrink to indicate which plate they are connected to. For slightly better noise characteristics, the cable with the yellow band should be connected to the high terminal of your capacitance bridge and the cable with the black band show be connected to the low terminal. If your bridge or LCR has four terminals, you will also need to connect High Voltage to High Current, and Low Voltage to Low Current. For more information on measuring the capacitance please see AP003 *Measuring the capacitance*.

The UC 200 has two capacitors, one for displacement and one for force. The cables are marked with yellow and black heat shrink, with double bands for force and single bands for displacement. Razorbill normally includes an MP240 multiplexer with sales of the UC200. Connect the force capacitor to L_1 (black) and H_1 (yellow), and the displacement capacitor to L_2 (black) and H_2 (yellow), then connect the capacitance meter to L_{com} (Low or sense) and H_{com} (high or excite). Connect the MP240 to a computer by USB, or to an Andeen Hagerling capacitance bridge sample switch port via a 15 pin D-Sub cable. If you are using USB, Razorbill Instruments offers a simple software tool to help you get started using serial commands, which can be downloaded from our website.

Mounting The cell

The cell can be mounted in various ways using the mounting points indicated in the technical drawings.

As well as simply holding the cell rigid, it is important to ensure that the cell is not held tightly by from more than one mounting point, especially if the material it is mounted to is of a dissimilar thermal expansion coefficient. In this case large forces could be applied to the cell as the cell is cooled down due to the differential thermal expansion.

Another consideration is that for low temperatures, particularly below 300 mK when the titanium of the cell chassis becomes superconducting, some thought must be put in to making enough thermal contact to adequately cool the cell and the sample. More details on these two issues is discussed in the application note AP001 *Thermal Expansion*.

Your first measurement

The cell will be used to apply uniaxial pressure to samples of material in order to tune the material's electronic properties. The largest effects will be produced if you use a small, matchstick shaped (thin cuboid) sample. The sample will need to be firmly held with epoxy from each end to sample plates that are anchored to the top surface of the strain cell. Because it can be challenging to consistently mount samples, please read the application note AP005 *Sample mounting tutorial* and the sample mounting guide on our website before mounting your first sample. We recommend that you practice with a non-essential sample during your first attempt at sample mounting.

If you probe technique requires wires to be attached to the sample after it is mounted, this can also be technically challenging. Having a nearby contact pad to bond can be very useful and Razorbill Instruments can supply suitable wiring platforms, part number WP101. One platform is included with each FC or UC type cell. Please see the WP101 datasheet for more information.

You must observe the temperature-dependent voltage limits set out in the user guide for your cell. At room temperature, this is –20 to + 120 V.

More information

Once you are familiar with the basics, you can find more information about how your cell works, how to design your experiment, and how to get the best from your cells in the following:

- The specific datasheet for your cell
- AP001 Thermal expansion application note
- AP002 Drive electronics application note
- AP003 Measuring capacitance application note
- AP004 Cables and heat load application note
- AP005 Sample mounting tutorial application note
- AP006 Sensor performance application note

If you have accessories with your cell, then you can find more information about them in their specific datasheets too.

- WP101 datasheet
- RP100 manual
- MP240 manual

All of these documents, and more, are available on our website razorbillinstruments.com