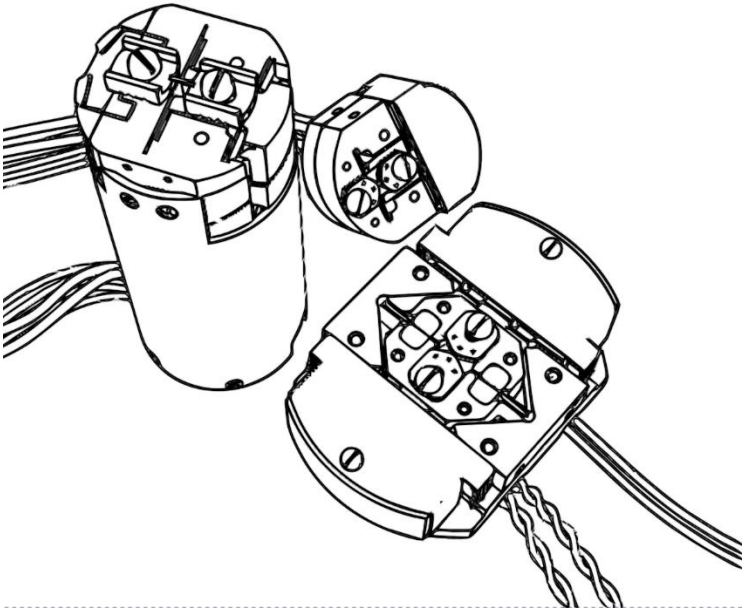


QUICK START GUIDE

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 three main types of device, the CS1X0 series strain cells, the CS2X0T series strain cells and the FC100 stress cell. The CS1X0 series consists of the same titanium chassis, but different lengths of piezoelectric stacks and are designated CS100 to CS130. Similarly the CS2X0 also use the same titanium chassis, with a wide access cone on the reverse, but also use different lengths of stacks. All of these types of device are used inside a cryostat to apply uniaxial pressure to samples. The shape and performance differ, and the CS1X0 and CS2X0 devices measure the applied displacement to the sample and the FC100 measures the applied force to the sample.

All three types of cell are driven by internal piezoelectric stacks. Both 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 (CS1X0 & CS2X0T) or the force applied to the sample (FC100). This capacitance can be measured using a capacitance bridge and converted to the displacement (CS1X0 & CS2X0T) or force (FC100) using the capacitance curve provided in the accompanying documentation.

WIRING & CONNECTORS

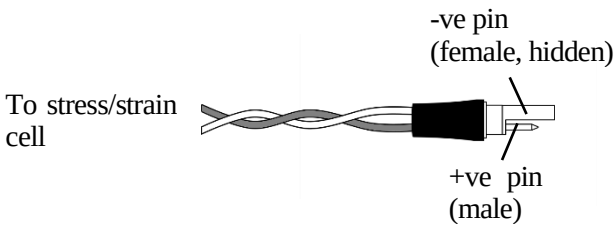


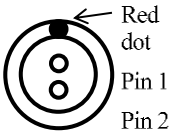
Figure 1. A LEMO FGG.0S.302.ZLAT connector indicating polarity. Note that as this is a hermaphrodite connector, the one on the cryostat cable will have the opposite polarity.

The strain cell drive wires are terminated with PEEK stepped 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. The mating connectors will be provided 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. 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.

For more information on measuring the capacitance please see AP003 *Measuring the capacitance*.

If you purchased a 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.

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*.

FIRST TIME SET-UP

The first time your stress/strain cell is used, you may need to perform a calibration procedure to measure the temperature dependence of the sensor, so it can be subtracted from your measurement. For FC100 and CS2X0 cells, this temperature calibration will already have been performed in the factory and a temperature calibration curve will be provided in the accompanying documentation. For CS100 cells, you should perform the following (the CS2X0 temperature calibration can also be periodically refreshed using this procedure);

1. Before using the strain cell, please perform the following background. First, at room temperature, with no sample mounted (no screws in the top face of the cell), apply 120V to both the tension and compression stacks, hold for a few seconds and then bring the voltage slowly back to zero. This ensures the stacks have the same voltage history and will go some way to reducing any differences in thermal expansion between the inner and outer stacks.

2. To perform the temperature calibration, we have supplied a titanium ‘dummy’ sample. This stiff piece of titanium will keep the cell at a strain that is identical to titanium for the entire cool down. Screw the titanium dummy sample into the tapped holes in the top of the cell (where you would usually mount the sample plates).

3. Mount the cell in your cryostat. Ensure that the HV wires are shorted together or connected to the power supply. The

sensor coax cables should be connected (via a feedthrough) to your capacitance bridge.

4. Perform your usual cool-down procedure. As you are cooling the cell, log the capacitance recorded on the capacitance bridge with respect to the temperature recorded in the cryostat. This will be your 'zero strain' capacitance corresponding to zero strain if your sample has the same thermal expansion properties to titanium. You can then use this capacitance to do a temperature correction for the sensor in future measurements.

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* 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, WP100. One platform is included with each FC100 cell. Please see the WP100 datasheet for more information.

MORE INFORMATION

- FC100 datasheet
- CS1X0 datasheet
- CS2X0 datasheet
- 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

Notes on accessories

- WP100 datasheet
- RP100 manual