Quick Start

ITC502 and ITC503 Temperature Controllers

If you have bought an ITC502 or ITC503 temperature controller and cryostat from *Oxford Instruments* the ITC will have been set up in the factory to suit the cryostat. The test results sheet will have been supplied with the cryostat manual, indicating the approximate values for all the parameters. This 'Quick start' is not intended as a substitute for the ITC Operator's Handbook but as a guide to help you to start using the system quickly.

If you have bought the temperature controller alone, or intend to use it with an existing cryostat you should refer to the Operator's Handbook for details of heater and sensor connections and calibration.

Unpacking

Unpack the temperature controller and check that you have found all the items listed on the packing list. If any items are missing or damaged, then please contact Customer Support Group at *Oxford Instruments NanoScience.*

Example

This example shows how easy it is to start using the ITC. The following pages describe how to carry out these steps in more detail. In this example the cryostat (or sample) temperature is set to 100 K and the system controlled automatically at this temperature.

- Press and release SENSOR in the HEATER area of the front panel to select the control sensor
- Press and hold SET
- Use RAISE and LOWER to set to 100 K
- Release SET
- Press and hold PROP and the value is displayed
- Use RAISE and LOWER to adjust it to a suitable value (given in the test results)
- Release PROP
- Repeat for INT and DERIV
- Press AUTO in the HEATER area of the front panel

The next step is only necessary for an automatic needle valve or closed cycle cooler.

- Press and release AUTO in the GAS FLOW area of the front panel (note that it toggles ON/OFF on ITC503.)

The ITC will now control the system at 100 K.

Preparing to use the ITC

Making connections

Caution: Before you connect the temperature controller to the mains supply, check that the voltage displayed on the mains connector socket at the back of the ITC matches the local supply voltage. If it is wrong refer to the full Operator's Handbook. Connect the mains lead and all cables.

Switching on the ITC

Switch on the ITC. At this stage the ITC will go through a short start-up sequence before displaying a temperature. If the auto needle valve lead has been connected, the gas flow light will flash on and off while the needle valve is initialised to its fully closed position.

If the ITC displays a message "Hot 1", "Hot 2" or "Hot 3" this means that the high temperature limit has been exceeded for channel 1, 2 or 3 respectively. Refer to *Checking that T_{hot} is set correctly* (see below).

Press the SENSOR button on the DISPLAY area of the front panel to select the sensor that you want to display (indicated by the light next to the display). If you hold down the button as you select the sensor the range code for that sensor will be displayed; RF52 for a rhodium iron resistor, for example. All sensors are measured continuously and it is not necessary to display the reading from the sensor that you are using to control the temperature.

Setting the limits to protect the system

Limits can be set in firmware to protect the system. These are:

- Maximum temperature limit (T_{hot})
- Heater voltage limit

Checking that T_{hot} is set correctly

This switches off the heater(s) to protect the system if the temperature exceeds the value "T_{hot}". Appropriate values are given in system test results if they are necessary for normal operation. Note that a different value of T_{hot} can be set for each sensor.

Check T_{hot} as follows:

- Press and release SENSOR on the DISPLAY area of the front panel to select the appropriate sensor (usually sensor 1 for continuous flow and Variox cryostats)
- Press and hold LIMIT (the LIMIT button is recessed behind the panel, so use a small implement to press it).
- Press and release SENSOR on the DISPLAY area of the front panel (T_{hot} is now displayed)
- Use RAISE and LOWER in the ADJUST area of the front panel to set the limit. For example, if the maximum normal working temperature of the cryostat is 300 K but it can safely be used at a slightly higher temperature then T_{hot} should be set at 310 K.
- Release LIMIT (the display now shows the temperature again)

Tip: For maximum protection set the T_{hot} limits for all the system sensors. If you set T_{hot} below 300 K, T_{hot} will be detected as soon as the ITC is switched on if the system is at room temperature. This may be acceptable on some systems but would be inconvenient on most.

Normally you will want these values to be kept in the non-volatile memory (so that they are still available after the ITC has been switched off and on again). Refer to the section on Saving Changes.

Tip: If T_{hot} is exceeded for more than 10 seconds the heater output will be permanently disabled (even though the display may register an output). Reset the ITC by switching it off and on again.

Checking that the voltage limit is set for the heater(s)

This limits the maximum voltage across the heater. The appropriate value will be given in the system test results if the heater is not suitable for the maximum output of the ITC.

Check or set the heater voltage limit as follows:

- Press and hold LIMIT (using a small implement)
- Press and release MAN in the HEATER area of the front panel (heater limit displayed)
- Use RAISE and LOWER to set appropriate voltage limit (between 0 and 40 V)
- Release LIMIT (temperature displayed again).

If you want these values to be kept in the non-volatile memory refer to *Saving changes.*

Caution: Do not connect a heater with a resistance < 20 Ω to the output of the ITC. If the heater resistance varies with temperature, make sure that the resistance does not drop below 20 Ω at any temperature.

Tip: If very small control powers are required (for example, a few mW) you can either set the heater voltage limit to a few volts or introduce a series resistor between the ITC and the heater. However, make sure that this resistor can dissipate the power safely without overheating.

Saving changes

If you want to save changes to the settings so that they are still available next time the ITC is switched on, press and hold LIMIT and press LOC/REM. The ITC displays the message **Stor**. Release both buttons. This saves all the current settings to permanent memory.

The ITC has an internal protection switch, which can be used to prevent changes being saved accidentally. Normally, when it leaves the factory, it is left so that changes can be saved. If the ITC displays **Prot** when you try to save the changes this indicates that the current settings are protected. Refer to the full Operator's Handbook.

Using the Temperature Controller

Setting a temperature

The ITC may be fitted with more than one sensor interface card. You can control the temperature on one sensor and display the temperature measured by one of the others.

- Press and release SENSOR in the HEATER area of the front panel to select the appropriate sensor for controlling the temperature, (indicated by the light in the HEATER area of the front panel)[1]. This is locked when the heater is put into AUTO mode
- Press and hold SET (set temperature displayed)
- Use RAISE and LOWER to adjust the set temperature
- Release SET and the display shows the temperature of the sensor indicated by the light in the DISPLAY area (not necessarily the control sensor)
- Select appropriate PIDs as described in Setting Proportional, Integral and Derivative terms below
- Press AUTO in the HEATER area of the front panel
- If you have an auto needle valve and want to use it, switch the gas flow to automatic mode as described in Setting a flow below.

You can now use the Sensor button in the Display area of the front panel to select the sensor that you want to display. This will not affect the operation of the system.

Setting Proportional, Integral and Derivative terms

Appropriate PID values for different temperatures are given in test results for the cryostat. The PID values can be adjusted at any time as follows:

- Press and hold PROP (proportional value displayed)
- Use RAISE or LOWER to adjust it
- Release PROP (temperature displayed again)
- Repeat for INT and DERIV

Note: On ITC503 the auto PID function may be used by pressing and releasing the AUTO button in the PID area of the front panel. This automatically looks up PID values for the set temperature from a table stored in firmware. If the light does not come on this indicates that no PID table is stored in the ITC. Use ObjectBench to load a suitable table into the ITC.

Tip: An 'autotune' function is available on ITC503 (using ObjectBench software) to select appropriate PID values.

Tip: If you want to adjust the PID settings to try to improve the temperature control the Operator's Handbook describes the effects of the three terms.

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[1] On most continuous flow systems and variable temperature inserts channel 1 monitors the heat exchanger sensor, and this is used to control the temperature. Channels 2 and 3 are used to monitor other sensors (for example, on the sample holder).

However, in summary:

- If the temperature tends to oscillate after reaching the set point try to increase PROP and then if necessary increase INT
- If the heat load on the system is varying rapidly and inducing disturbances in the temperature it may help to reduce PROP and INT
- DERIV is set to zero for steady control at a constant temperature on most systems
- A small value in DERIV, (typically 0.25 × INT) is sometimes used to reduce overshoot. It can also help if you increase PROP slightly. However, *Avoiding overshooting the set temperature* on page 6 describes an alternative technique which is usually simpler to use.

Setting a flow

This only applies to systems with auto needle valves or closed cycle coolers. Auto needle valves are initialised to the fully closed position when the ITC is switched on. The flow can be set automatically or manually. If you use manual mode, refer to the system test results for the approximate setting. The procedures for running ITC502 and ITC503 are slightly different.

Note If you are operating a CF cryostat at or below 4.2 K the needle valve flow has to be set manually (even if an auto needle valve is fitted). On Variox cryostats manual operation is recommended below 4.2 K. Above this temperature either mode can be used.

Note The speed of some closed cycle coolers can be controlled by the gas flow control output of the ITC if special firmware is loaded. Refer to the full Operator's Handbook.

ITC502

For automatic operation press and release AUTO in the GAS FLOW area of the front panel. The light above the AUTO button is ON during automatic control.

For manual adjustment press and hold MAN in the GAS FLOW area of the front panel and use RAISE and LOWER to set the flow valve position between 0% (fully closed) and 100% (fully open).

ITC503

On ITC503 the AUTO button in the GAS FLOW area of the front panel acts as a toggle switch. If you press and release it, the ITC will switch between the automatic and manual modes. It is in manual mode if the light is off and automatic mode if the light is on.

For manual operation, press and hold AUTO in the GAS FLOW area of the front panel. Use RAISE and LOWER to set the flow valve position between 0% (fully closed) and 100% (fully open). Release all the buttons.

Setting a heater voltage

During automatic control the temperature controller adjusts the heater voltage continuously. You can display the heater voltage output by pressing and holding AUTO on the HEATER area of the front panel.

The heater output voltage of the ITC can be set manually as follows:

- Press and hold MAN in the HEATER area of the front panel
- Use RAISE and LOWER to adjust the voltage (which is shown on the display)
- You can display the heater output by pressing and holding MAN

Avoiding overshooting the set temperature

Sometimes it is important that the temperature does not overshoot the set point significantly. If you have set a large change in temperature it is difficult in practice to prevent this from happening, even if you spend a long time optimising the PID settings. Different PID settings may be required for temperature steps from different temperatures. However, if you change the set temperature in two steps (with the second step much smaller than the first) the overshoot can be reduced to an acceptable level.

For example, if the system is at 100 K and you want to change the temperature to 200 K without overshooting the temperature significantly, set two steps. First set 195 K and when the temperature overshoots 195 K and starts to stabilise, set 200 K. The overshoot from this small change in temperature is likely to be much smaller, the whole step from 100 to 200 K will be quick and it is easier to find PID settings that are sufficiently good.

You can use the SWEEP function to set these steps if you like. Refer to the full Operator's Handbook for further details.

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