

# Auto Needle Valve

For **ITC502** and **ITC503**

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## Warnings

Before you attempt to install or operate this equipment for the first time, please make sure that you are aware of the precautions which you must take to ensure your own safety.

Do not plug in the auto needle valve while the temperature controller is switched on.

This manual refers to the Oxford Instruments auto needle valve motor with a flexible plastic cover, and not to previous versions. Other versions are sometimes used for special applications and these are described briefly at the end of the manual.

# **1 Introduction**

## **1.1 Introduction - which parts do you need to read?**

This manual explains how to fit the Auto needle valve assembly to the needle valve of an Oxford Instruments cryostat or LLT or GFS transfer tube, and connect the Oxford Instruments ITC502 or ITC503 temperature controller. It supplements the information given in other manuals supplied with your system. The cryostat manual explains how to run the system after it has been set up. The temperature controller manual gives details about the hardware and software within the temperature controller and the theory of gas flow control. If you have bought a complete system you should not need to use this manual unless you need to make adjustments.

If you have bought a kit of parts to upgrade an existing cryostat or transfer tube you will need to read section 2.2 which explains how to fit the motor to the needle valve, and then section 2.3 which explains how to set up the temperature controller. This manual also gives a brief description of the techniques used to operate the system in case your existing system manuals do not describe it.

## **1.2 Safety requirements**

Please refer to the separate safety booklet supplied with the system. This includes information about the properties of liquid nitrogen and liquid helium, and detailed recommendations about the precautions you should take. It is your responsibility to ensure your own safety, and the safety of the people working around you.

## **1.3 The Auto needle valve and Auto LLT**

The Auto needle valve and the Auto LLT are two similar applications of the hardware which allows the ITC502 and ITC503 to control a valve using a stepper motor. In most respects they are identical. They are used to control and optimise the flow of a cryogen within (or into) a cryostat. This flow is adjusted so that the amount of power supplied to the temperature control heater reaches the target value set in a table held in the temperature controller. The main difference is that for the Auto LLT the motor is fitted to a needle valve on the LLT transfer tube, whereas for all other applications it is fitted to the cryostat itself. This manual can also be used for the AutoGFS transfer tube, a previous design.

In AUTO mode the temperature controller can be used to set up a programmed experimental run over a wide temperature range, with the cryogen flow optimised throughout the experiment.

The valve can also be controlled manually through the temperature controller's 'MAN' mode. This allows control of the valve from the front panel of the temperature controller or through a computer interface, so you can operate the system remotely.

The ITC temperature controllers use an algorithm which adjusts the cryogen flow until the heater voltage reaches the 'ideal heater voltage' for the set temperature. The ideal heater voltage is held in four 'look up' tables in the temperature controller, and one of these is selected to suit your system. Three of these tables are pre-set and cannot be changed. The fourth table must be downloaded from a computer to the temperature controller if it is needed; this is only used for special systems that cannot be controlled using one of the pre-set tables. Other factors can also be set up in the controller to optimise it for the system.

You may find that the cryogen flow stops when the valve position reading on the temperature controller is as high as 20%.

The Auto needle valve and Auto LLT are optimised for use with liquid helium. They can also be used with liquid nitrogen in MAN mode, but AUTO mode is not recommended.

## **1.4 Using the ILM200 series level meter**

The ILM 200 series level meters can also be used to control the auto needle valve. One common application is to control the flow of liquid helium within a cryostat, so that the liquid level in one container can be maintained by filling it from the liquid helium reservoir. Full instructions are given in the ILM manual.

## 2 Installation and set-up

If you have bought the auto needle valve as a kit you should follow the instructions in this chapter to install it on the system. If your system is already assembled you should not need to read this chapter.

### 2.1 Check that you have the components

You should find the following components in the kit:

- Motor/gearbox and assembly kit
- Cable to connect the motor to the Auxiliary socket on the temperature controller or ILM.

**Caution**

The motor is supplied correctly wired with a micro-switch fitted, and one or two springs between the aluminium body and the brass body. These two parts are taped together to prevent the springs from falling out. Do not remove the tape until you are instructed to do so (see below).

## 2.2 Assembling the auto needle valve

If you are adding an auto needle valve to an existing system follow these instructions. Otherwise you only need to read this section if you have to remove the needle valve from your system. Refer to the diagram on page 10.

- Remove the needle valve shaft from the cryostat or transfer tube as follows. Turn it anti-clockwise until the thread disengages and pull it out, taking care not to bend the needle valve shaft. Take off black knurled needle valve knob. Recent systems will have these handles attached by grub screws, which can be removed easily and kept to fit the motor assembly. On older systems you can only remove the handle by driving out the roll pin. This may be very difficult. Make sure that the far side of the handle is supported well so that the shaft is not damaged. If you cannot drive it out you may be able to drill it out but the pin is hardened.
- Remove the 'O' ring from the phosphor bronze top fitting.
- If necessary, modify this fitting as shown on the diagram on page 10. Drill a 4.1 mm hole, 10 mm deep, centrally in the top of the fitting. Tap the 4 mm diameter cross hole using an M4 × 0.7 mm tap. Make sure that the drive shaft of the motor fits freely into the 4.1 mm hole.
- Remove any swarf from the phosphor bronze assembly and fit a new 'O' ring (our part number VOZ0007), lightly greased with silicone vacuum grease. Clean the needle and thread thoroughly.
- Replace the needle valve shaft in the cryostat or transfer tube, making sure that you do not get vacuum grease from the 'O' ring on the thread or needle. Gently close the needle valve fully.
- Slide the motor assembly onto the phosphor bronze fitting. Make sure that the flat on the drive shaft lines up with one of the tapped holes and that none of the flat is visible (as the shaft is fully engaged in the hole).
- Use an M4 grub screw to fix the shaft into the hole firmly. Then remove the tape that holds the aluminium and brass parts together.
- Rotate the aluminium micro-switch carrier to set a 3 mm gap for the micro-switch arm and a gap of 1.5 mm between the aluminium and the brass bodies, as shown on the drawing. Use an M4 × 6 mm long grub screw (in the hole marked "auto needle valve fixing" in the drawing) to clamp the aluminium part to the stainless steel needle valve guide tube.
- Connect the motor to the ITC temperature controller and switch on the ITC. If the ITC is not already set up to operate an auto needle valve follow the instructions in section 2.3. If you don't know how to operate the needle valve motor from the ITC see section 3 for instructions.
- Check that the motor stops when the needle valve is fully closed. Then set the ITC to open the needle valve to (say) 50% and check that the needle valve is driven open and stops. Then fully close the needle valve again and check that the motor stops.
- Push the blue plastic cover over the motor assembly, gently rotating the cover as you push it on. Make sure that you do not damage the micro-switch or wire connections as you fit the cover.

## 2.3 Setting up the temperature controller

This describes how to set up the auto needle valve on the ITC502 and ITC503 temperature controllers. If you are trying to install it on an ITC4 you should use the ITC4 manual.

The temperature controller manual explains how to set up these parameters. It also explains how to interpret the meaning of the numbers, so that you can tell which features are in use for each setting.

### 2.3.1 Factors affecting the way the temperature controller is set up

The factors affecting the way the temperature controller chooses the optimum valve setting are described below. The ITC502 and ITC503 have different control algorithms so some of the control factors are different.

#### For both ITC502 and ITC503

Parameter	Function and description
Temperature error sensitivity Heater error sensitivity.	These are the fundamental tuning parameters of the algorithm. They determine the extent to which temperature errors and departures from the target heater voltage affect the output. Although it is possible to change these values while the system is running it is not usually necessary. Small changes can have a large effect on the stability of the system.
Heater voltage limit	Set for the heater and cryostat that you are using
Gas flow scaling	Allows fine tuning adjustments to be made easily while the system is running.
Auto LLT sense input	This connection is made automatically when the standard auto needle valve cable is plugged into the temperature controller.

#### For the ITC502 only

Parameter	Function and description
Gas flow parameter	Set for system type.
Target voltage table range	A scaling factor introduced to optimise the system if you only want to use part of the temperature range of the thermometer sensor.

#### For the ITC503 only

Parameter	Function and description
Target table and features Valve gearing	Both values are set for system type and they should not need to be changed.

### 2.3.2 Table of typical values for all parameters

The details of parameters to be set in the ITC502 are slightly different from those in the ITC503. The tables on page 9 show the recommended starting values for a range of typical systems.

## 2.4 Technical specifications of motor and gearbox

Motor step angle	6°
Approximate line voltage from ITC	11 V
Nominal phase current at 11V	70 mA per phase
Nominal resistance of each coil	165 Ω
Gearbox reduction ratio	376:1

## 2.5 Electrical connections

### 2.5.1 Connections within the motor housing.

Motor circuit board	7 pin Fischer connector (on motor)
1	2
2	5
3	4
4	5
5	5
6	1
7	5
8	3

#### Notes.

Pins 2, 4, 5 and 7 on the motor circuit board are connected together.

Pins 6 and 7 on the Fischer connector are used for the micro-switch.

### 2.5.2 Cable from the motor and the temperature controller

7 pin Fischer connector	15 way D connector for ITC
1	2
2	1
3	10
4	9
5	15 (+12 volts)
6	5
7	7

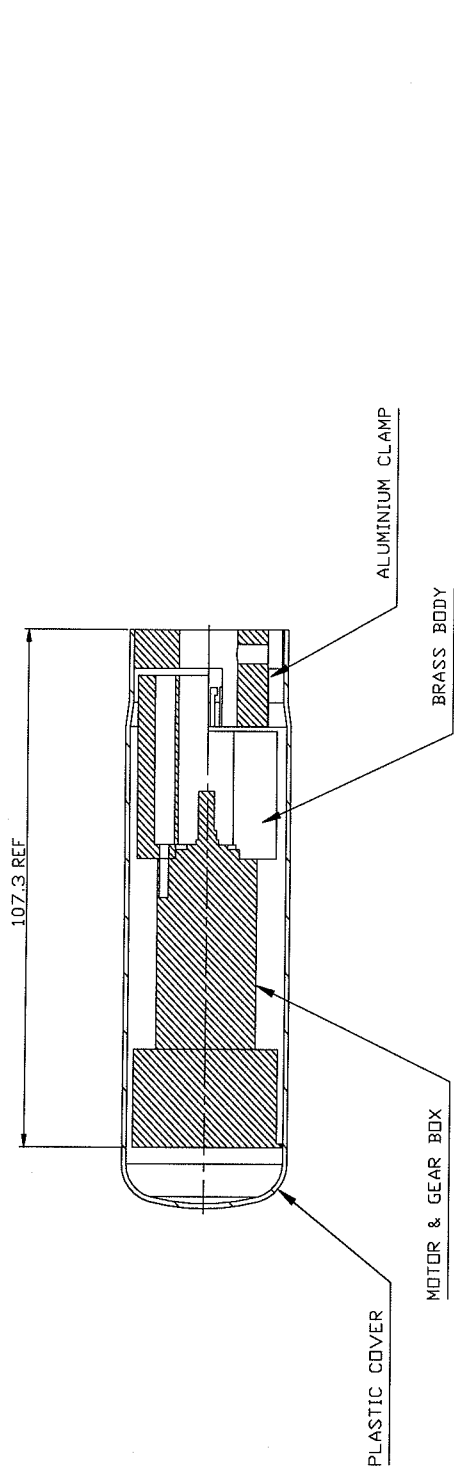


### Typical parameter values for some systems using ITC502 temperature controllers

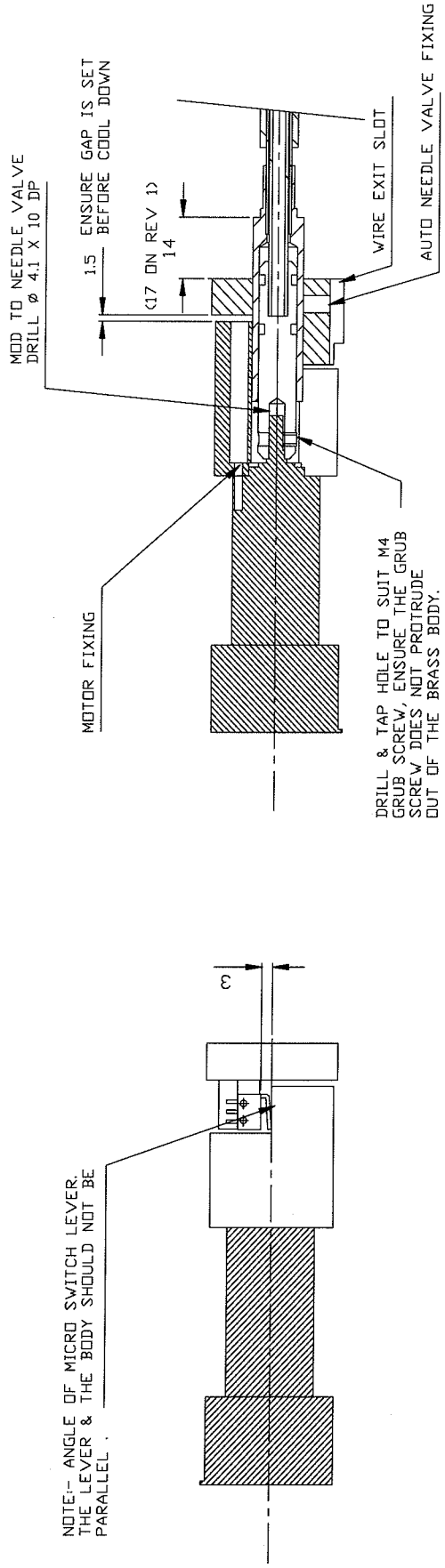
Type of system	Gas flow parameter	Target voltage table range	Temperature error sensitivity	Heater error sensitivity	Heater voltage limit	Gas scaling factor
Helium bath cryostat with variable temperature insert (dynamic or static)	122	99.9%	9	11 to 13	20 to 40	25 to 30
Continuous flow helium cryostat with Auto LLT (or Auto GFS)	121 (or 122)	99.9%	9	11	20 to 40	20 to 50
Variox	121 (or 122)	99.9%	9	11	20 to 40	20 to 50
CF1200V for VSM (with custom target table)	241	60	10	14	25	99.9
Custom values for your system						

### Typical parameter values for some systems using ITC503 temperature controllers

Type of system	Target table and features (C2)	Valve gearing (C1)	Temperature error sensitivity (C4)	Heater error sensitivity (C5)	Heater voltage limit	Gas scaling factor (C3)
Helium bath cryostat with variable temperature insert (dynamic or static)	71	2	9	11 to 13	20 to 40	25 to 30
Continuous flow helium cryostat with Auto LLT (or Auto GFS)	71	1 (or 2)	9	11	20 to 40	20 to 50
Variox	71	1 (or 2)	9	11	20 to 40	20 to 50
CF1200V for VSM (with custom target table)	199	1	10	14	25	99.9
Custom values for your system						



NOTE:- ANGLE OF MICRO SWITCH LEVER, THE LEVER & THE BODY SHOULD NOT BE PARALLEL.



**Assembly of the standard auto needle valve (based on drawing number ADZ1515 revision 4)**  
 (Details of the components may vary from one system to another.)

## **3 Using the auto needle valve**

This is a short guide to using the auto needle valve assuming that it has already been fitted. If it has not been fitted, refer to section 2 of this manual for instructions. These guidelines are intended for systems that do not already have full instructions elsewhere. For many systems you do not need to know how the auto needle valve works as the software sets it automatically.

### **3.1 Preparing for operation**

Switch off the temperature controller and then plug the auto needle valve cable into the auxiliary port.

Switch on the temperature controller. The LED on the gas flow panel will flash for up to 4 minutes 30 seconds as the temperature controller 'initialises' the auto needle valve. This process will stop as soon as the valve is fully closed. The buttons on the gas flow panel are disabled during initialisation, but the other features of the temperature controller can be used in the normal way. When the LED stops flashing the initialisation process is complete.

If the auto needle valve is unplugged during initialisation the process will stop. It will not start again even if the auto needle valve is reconnected. Switch the temperature controller off and on again to re-start initialisation.

### **3.2 Manual mode**

The ITC502 has two buttons (AUTO and MAN) to select automatic or manual mode. The ITC503 has one button (AUTO), and the instrument can be 'toggled' between automatic and manual modes by pressing this button. Select manual mode. You can now set the position of the valve by pressing and holding MAN (on ITC502) or AUTO (on ITC503), and using the RAISE and LOWER buttons. ("RAISE" opens the valve, and "LOWER" closes it). This allows you to adjust the cryogen flow. You can use a computer to control it through the RS232 or optional GPIB port of the temperature controller.

The valve starts to respond instantly to changes in the set position but it may take several minutes to reach the set position (depending on the selected number of steps between 0% and 100%). If you press the MAN or AUTO button again before it reaches its new set position the valve will stop, and the current position will be displayed until you release the button. This becomes the new 'set' value, so you have to reset the 'set' position if you want to continue to the original set position.

For example, if the valve is currently 20% open, and you set it to open it to 50%, the valve will start to move as soon as you release the MAN (or AUTO) button. Typically it will take about 20 seconds to reach the new set point. However, depending on the way the temperature controller is set up it could take up to 80 seconds. If you press the MAN (or AUTO) button again during that time the valve will stop opening and the temperature controller will display the current position. If you still want to open the valve to 50% you have to reset it again, using MAN (or AUTO) and RAISE/LOWER.

### 3.3 Automatic mode

If you set AUTO mode the valve position will be automatically controlled by the temperature controller. You can display the valve position at any time by pressing the AUTO button. On ITC503 the AUTO button is used to 'toggle' between manual and automatic modes, so you then have to press AUTO again to return to automatic mode.

The parameters set in the temperature controller affect the position of the valve for a particular set temperature and cryostat temperature. In general only one of these parameters needs to be adjusted while the system is running. This is the 'gas flow scaling factor'. This factor applies to the whole of the temperature range of the system, so it may be necessary to optimise it again for different 'set' temperatures. The temperature controller manual explains how to adjust this parameter.

If the gas flow scaling factor is increased, the flow rate will be increased and the target heater voltage within the temperature controller will be increased accordingly

### 3.4 Fault finding

You can check whether the needle valve is turning by removing the blue plastic cover. You should be able to see the needle valve rotating slowly.

#### Fault

Needle valve not turning

#### Diagnosis and possible solutions

Check that the gearbox output shaft is firmly fixed to the needle valve shaft.

Check whether the needle valve is closed too tightly for the motor to open it.

Remove the cover and check whether the motor is turning.

Check for grease or moisture on the needle or thread, and clean it if necessary.

Check for an air leak on the 'O' ring at the top of the needle valve shaft.

Motor not turning

Check the wiring.

Disconnect the motor from the needle valve and see whether the motor turns with no load.

Needle valve sticking after the first cooldown.

Mark the position of the aluminium part of the auto needle valve relative to the fixed part of the needle valve. Loosen the screws which fix it to the base plate and turn the whole assembly to open the needle valve. Then turn it back to near its original position and clamp it again.

### **3.5 Auto needle valves for special applications**

Other designs of auto needle valve are available to suit special applications. Their operation is usually the same as that described above. They cannot easily be fitted to existing systems so we have not described how to assemble them.

The principal differences are usually as follows:

- The motor may not be in line with the needle valve shaft
- The drive may be through a toothed belt (not direct)
- A different gearbox may be fitted
- The wires marked 3 and 8 on the motor circuit board are swapped to reverse the direction of rotation of the motor

One addition is required for the Fault-Finding section. If the needle valve is not turning but the motor is turning it is possible that the teeth on the drive belt are worn and the belt should be replaced.

If you require more information about a special auto needle valve please contact the Customer Support Group at the address on the front cover of this manual, quoting the project number for your system.