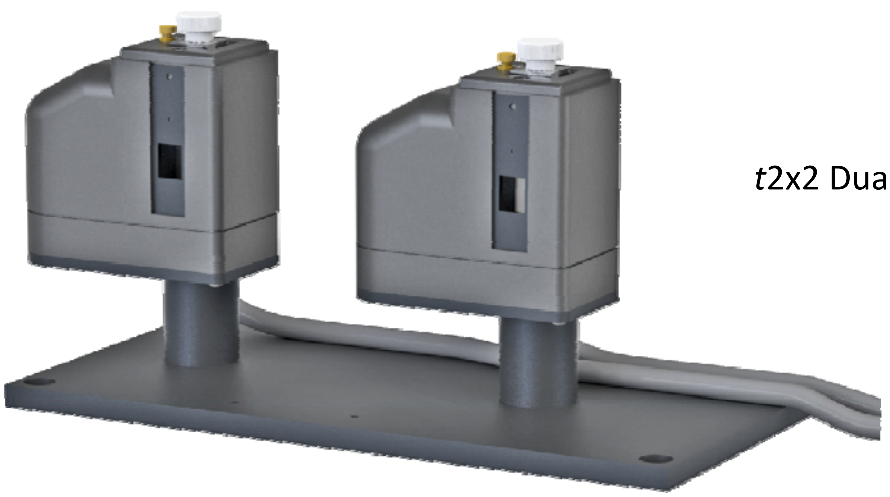
*t*2*x*2

Dual Temperature-Controlled Cuvette Holder for UV/Vis Spectrophotometry

Manual & Product Overview



*t*2x2 Dual Cuvette Holder

TC 1 Temperature Controller

QUANTUM
N · O · R · T · H · W · E · S · T

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1. GETTING STARTED

Thank you for purchasing a Quantum Northwest ***t***2x2! We want you to enjoy many years of faithful service from your instrument. If you have any questions, feel free to contact us directly through our web site: www.qnw.com.

A. YOUR SHIPMENT WILL CONTAIN:

t2x2 package

1. ***t***2x2 cuvette holder
2. **TC 1** Temperature Controller
3. power cable
4. USB cable
5. magnetic stir bar
6. vinyl tubing and hose barb fittings to connect water and gas

B. DEPENDING ON YOUR ORDER, YOUR SHIPMENT MAY ALSO CONTAIN:

Installation package

Installation packages are available for a number of spectrometers. If you purchased such a package, it will contain instructions for installation, including how to mount the unit and how to connect utilities (electrical cable, circulating water for the Peltier unit and dry gas) to the cuvette holder.

BATH 10

1. submersible pump adapted to 1/8-inch ID tubing
2. plastic bucket

T-App software

T-App, provided on a CD, is a program that permits external computer control of the **TC 1** Temperature Controller. The temperature of each of the sample holders and a temperature sensed by an external probe may be plotted vs time. Simple text scripts may be used to automate multiple operations.

C. SYSTEM SETUP

1. Install the ***t***2x2 in your spectrometer. (It may have been already installed by the manufacturer.) If you purchased an installation package from us, follow the enclosed directions.

2. Supply circulating water to the two Peltier units. Use two short lengths of 1/8-inch tubing to connect the 1/8-inch T to the bottom hose barbs of each cuvette holder. Connect the top hose barbs in a similar way. If you purchased the **BATH 10**, then attach tubing from the submersible pump to either hose barb T. Attach another piece of tubing from the other T back to the bucket. Put water in the bucket, turn on the pump by plugging it into an outlet and check to be sure that water is flowing back into the bucket. Sometimes water will only flow through one of the cuvette holders. To prevent this, pinch each of the input lines in turn to force residual air out of the other cuvette holder. Check for leaks. Unplug the pump until you have completed the remainder of the system set up.

3. If you plan to work at low temperatures, connect a source of dry gas (typically nitrogen) to release on the cuvette windows. Use two short lengths of the 1/16-inch tubing to connect the 1/16-inch T to the small dry gas hose barbs of each cuvette holder. Use 1/16-inch tubing to provide dry gas to the T, when working at temperatures below the dew point, typically 5 °C or so. A 1/8 to 1/16-inch barbed reducer fitting is included, if needed, to assist you in connecting to this unusually small size tubing. Set the dry gas flow rate to about 50 cc/min. It is essential never to put water through the gas line!

4. Connect the electrical cable from the sample cuvette holder to the 15-pin connector labeled "Sample" on the back of the **TC 1** Temperature Controller, and the cable from the reference cuvette holder to the connector labeled "Reference".

5. Plug the power cable into the back of the **TC 1** Temperature Controller and into a wall socket. (The **TC 1** will accept AC voltages from 85 to 264 at 50 or 60 Hz.)

D. SOFTWARE INSTALLATION

1. If you purchased the **T-App** program for external control of the ***t***2x2, insert the CD into the drive. If the installation does not start automatically, locate the Setup.exe file in the root directory and run it. The installation process starts with a small black window that is shown during installation of the drivers needed to control the ***t***2x2 through a USB connection. This window will then be replaced by the software installation window. Follow the onscreen prompts to complete the installation.

2. Connect the **TC 1** to your computer using the USB cable provided. The New Hardware installation process will begin automatically and take a few moments to finish.

E. SYSTEM OPERATION

1. Use a liquid sample in a standard 1 x 1-cm square cuvette and place it in the closer cuvette in the sample beam. Place a cuvette with solvent in the holder in the back

2. Place magnetic stir bars in the cuvettes.

3. If you wish to monitor the temperature inside one of the cuvettes, plug a standard Series 400 or Series 500 thermistor probe (not provided) into the ¼ - inch phone jack labeled "probe" in the back panel of the **TC 1**. Place the end of the probe in a region of the solution, where it will not occlude the spectrometer light beam.

4. Turn on the circulating water.

5. Turn on the main power of the **TC 1** controller using the switch on the back panel.

The Menu Button

6. To simply set a temperature and turn on magnetic stirring, use the right arrow to go to the **Set Sample Temperature** page, use the up and down arrows to set a target temperature, say 37.0 °C. Press **SET** to retain this value. This will take you to the **Set Stirrer** page. Use the up and down arrows to set a speed, say 1200 rpm, and press **SET** to start the stirrer. Finally, use the right or left arrows to go back to the main **Start** page that displays the sample and reference temperatures. Press **SET** to initiate temperature control. Since the controller will default to setting the same parameters for both the reference and the sample, the temperature of both cuvette holders will rise and stabilize at the new value.

7. Press **SET** again on the **Start** page to turn off temperature control when it is running.

8. After measurements are completed, turn off power on the back of the **TC 1** controller and turn off the water source.

2. USING THE MENU BUTTON

The menu button allows complete control of temperature, magnetic stirring and ramping for the sample and reference, either together or separately. Use the left or right arrows to cycle through the five pages permitting temperature, stirring and ramping settings:

– Start – Set Sample Temperature – Set Sample Stirrer –

Set Sample Ramping – Set Reference –

```
        Sample Ref
Temp˚C  60.0   60.0
Target  60.0   60.0
Probe   59.1˚C
```

Start: This main page displays the actual cuvette *Holder* temperature as well as the *Target* temperatures that you set for both the sample and reference cuvette holders. If a thermistor probe is being used, it also displays a *Probe* temperature. After a few seconds of inactivity, all other pages will switch back to this **Start** page. Press **SET** on the **Start** page to start temperature control to seek the Target temperature. Press it again to stop.

```
Set Sample Temp.

Target =  20.0˚C
Current=  60.0˚C
```

Set Sample Temperature: To set the *Target* temperature for the sample, use the up and down arrows. Press **SET** to retain this value.

```
Set Sample Stirring

Stir Speed =  800rpm
Current = 1200rpm
```

Sample stirring: To turn on magnetic stirring for the sample, use the up and down arrows to choose an approximate stirring speed. Press **SET** to set this stirrer speed. The stirrer will immediately turn at approximately this speed until you either change it again.

```
Set Sample Ramping

Ramp = 0.50˚/min
Current = 0.50˚/min
```

Sample ramping: To perform a ramp, choose the Ramping rate using the up and down arrows. Press **SET** to retain it. Later, when you begin temperature control on the **Start** page, the temperature will use this rate to get to the target temperature. This rate will be maintained until you set it back to zero. The fastest possible ramp is determined by how fast the cuvette holder could reach the target temperature without ramping. The slowest ramp that may be set on this page is 0.01 °C/minute. (If needed, much slower ramps may be set through software commands.)

```
Set Reference
Copy Sample Settings
Yes
```

Copy Settings: In the default condition, **Yes**, the controller operates the reference identically to the sample. Choosing **No**, using the up or down arrow, causes the following three additional pages to appear, permitting the setting of the Reference parameters independently.

– Set Reference Temperature – Set Reference Stirring – Set Reference Ramping –

```
Set Ref Temp.

Target =  30.0˚C
Current = 60.0˚C
```

Set Reference Temperature: Set a separate target temperature for the reference cuvette .

```
Set Ref Stirring

Stir Speed = 1500rpm
Current = 1200rpm
```

Set Reference Stirring: Set the speed of the reference stirrer.

```
Set Ref Ramping

Ramp = 0.55˚/min
Current = 0.50˚/min
```

Set Reference Ramping: Set a reference ramp rate.

3. *FEATURES OF THE t*2x2

A. General description

The ***t***2x2 consists of two temperature-controlled cuvette holders mounted on posts, one is used for the sample and the other for the reference. Each holder is constructed of two molded parts surrounding a metal tower to hold the cuvette. Each has a thermoelectric (Peltier) device mounted to one side of the tower for temperature control. Heat exchangers mounted to the thermoelectric devices use a flow of water to drain off excess heat. Small electric motors turn magnets under the towers for stirring, using delicate neoprene belts. Dry gas may be directed next to the cuvette windows to minimize condensation when working below the dew point temperature.

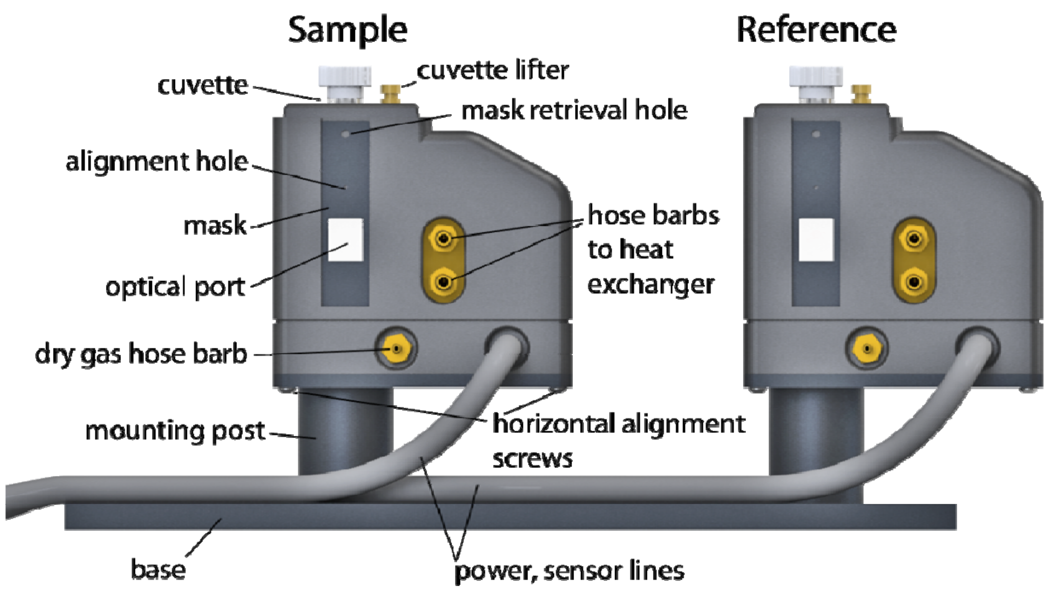

Figure 1. ***t***2x2 consisting of two cuvette holders mounted on posts

Optical masks is placed on each side of each holder create optical ports. Two 1/8-inch hose barbs for water provide access to the heat exchanger. 1/16-inch hose barbs are used for the dry gas. These hoses and the power and sensor cable must be brought out of the sample compartment by a means that does not interfere with the spectroscopic measurement. Access for these utilities may need to be light tight.

B. Cuvette holder

Each cuvette holder holds a standard 10 x 10 mm cuvette with outside dimensions of 12.5 x 12.5 mm. Metal clips are used to push the cuvettes into corners for reproducible positioning and to favor temperature transfer. Walls of the towers are relieved to prevent scratching of the optical surfaces of the cuvettes. The towers are tall enough to surround the full height of a standard size cuvette, and cuvette lifters will lift the cuvettes for easy access.

Cuvettes must be taller than 30 mm, or they will pass below the metal clip and become stuck.

C. Cuvette z-height

The “z height” of a cuvette is the distance between the bottom surface of the cuvette and the designed position for the optical center line, where the incident beam of light strikes the cuvette. The z height for the t2x2 is specified as either 8.5 or 15 mm when ordering.

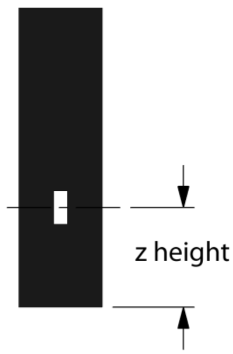

Figure 2. The z height of a typical microcuvette

Most spectrometers are designed for a z height of either 8.5 or 15 mm, although the Agilent Cary line of spectrometers usually uses 20 mm. For most standard cuvettes, z-height does not matter, since light can pass anywhere through the sides. Using these standard cuvettes, higher z height simply requires the use of a larger volume in the cuvette. On the other hand, many specialty cuvettes such as flow cells and microcells must be designed specifically for the z height. Such cells are typically made for a z height of 8.5, 15 or 20 mm.

For a 15 mm z height, the post is made shorter, so the beam will strike the cuvette higher. Masks are placed on each side of the cuvette providing light access at the correct height.

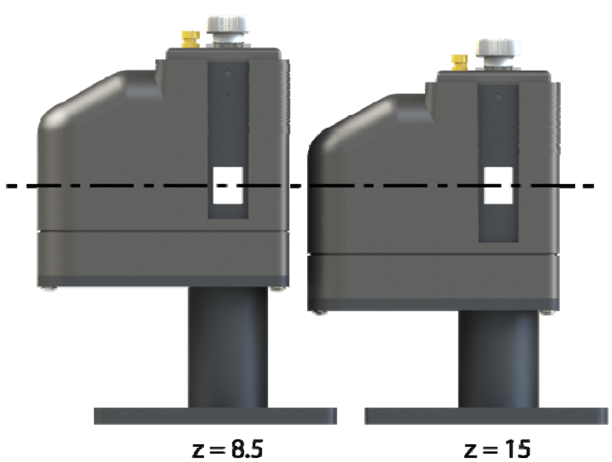

Figure 3. Mask and post height determine z height.

D. Alignment for microcuvettes

It is quite possible that a spectrometer beam may not be in precisely the right position to pass light through the small window of a microcuvette, and a small horizontal adjustment may help. To align a cuvette holder, remove the mask from one side of the cuvette. The mask is firmly in place so it does not move during measurement, but by applying some force at the mask retrieval hole at the top it can be slid upward using the end of a paper clip or similar tool. Turn the mask upside down and reinsert it. A 1 mm hole then marks the optical center line of the cuvette. Loosen the three horizontal alignment screws on bottom corners of the cuvette holder and slide back and forth until you get the alignment you desire. The holder will only move about a mm in each direction. If the spectrometer alignment is further off than this, then it should be aligned instead of the cuvette holder. Alignment may not be important for spectrometers with large or poorly focused light beams.

E. Cooling water for the Peltier

The Peltier element (or "thermoelectric cooler") is a heat pump. When cooling, it transfers heat from the cuvette tower to heat exchanger; when heating, electrical polarity is reversed and it transfers heat from the heat exchanger to the tower. When cooling, it is particularly important to transfer this heat away from the Peltier. This is accomplished with flowing water through the heat exchanger.

A source of water (or other cooling fluid) must be connected to the ⅛-inch hose barbs on the side of the ***t***2x2. If you purchase the **BATH 10** from us, you will get an inexpensive submersible aquarium pump, the appropriate fittings for connecting tubing, and a plastic bucket. Connect the pump to the ***t***2x2, place it in the bucket with water, and run a return tube to the bucket. A more robust pump is available as the **BATH 100** for a higher price, although the larger pump has a higher Wattage and tends to heat the water when used for extended periods of time.

You may also provide the cooling water from another source, such as a refrigerated cooling bath or even a tap for brief use.

You will need a flow of 100 - 300 ml/minute. This flow should require a pressure of about 3 - 5 psi (0.2 - 0.3 bar). Do not exceed an input water pressure of 25 psi (1.7 bar), as damage may occur inside the ***t***2x2. The heat exchanger and hose barbs are brass, and the tubing inside the ***t***2x2 is vinyl. Be sure that any circulating fluid used, other than water, will not corrode these materials.

The temperature of the heat exchanger in the ***t***2x2 is monitored using a thermistor. If the temperature exceeds 60 °C, then temperature control is shut down to prevent damage to the Peltier element and the warning, "check coolant flow," displayed on the **TC 1** temperature controller. This will happen if the circulating fluid gets too warm and/or is restricted in flow. The heat exchanger temperature may be accessed by computer through the RS 232 or USB connections on the back of the **TC 1** Temperature Controller (see External computer control below).

Temperature increases will be faster when room temperature water is used in the circulator. Temperature decreases will be faster when ice water is used. Only water should be circulated using the **BATH 10**. When using a refrigerated bath, circulating pre-cooled fluids (such as 30% methanol or diluted ethylene glycol) at below 0 °C will permit measurements below the specified temperature range.

F. Dry gas to minimize condensation

Dry gas flows into the cuvette holders via the small hose barb in the base. It passes up through holes below the optical ports in the cuvette tower to fill the space between the cuvette and the optical mask, preventing condensation on the surfaces of the cuvettes. A flow of dry gas is necessary any time the ***t***2x2 is controlled below the dew point temperature present on the inside of the sample compartment of the spectrometer. For ambient air, this would typically be about 5 °C.

G. External temperature probe

A ¼-inch phone jack labeled "Probe" can be found on the back panel of TC 1 Temperature Controller. This jack will accept the plug on a standard Series 400 or Series 500 thermistor probe. When a probe is plugged into the jack, the probe temperature is presented on the display of the TC 1. Place the probe in the sample to measure the actual temperature of the sample, which will lag in time from the temperature of the cuvette tower.

We do not sell the probe, but there are many Series 400 and 500 probes on the market. Quantum Northwest's preferred probe is the YSI 423 available from Cole Parmer. The YSI 423 is reasonably resistant to immersion and responds rapidly to temperature changes. Also, the fine, coiled wires of the YSI 423 conduct very little ambient heat to the thermistor at the end.

Excellent Series 500 probes can be obtained with diameters less than a mm, providing access to small volumes. A disadvantage of these probes is that they are not pre-calibrated.

H. External computer control

All functions may be accessed either through a Serial (RS 232) or a USB located on the back of TC 1 Temperature Controller. You may write your own program or purchase our application program T-App. T-App will plot temperatures of the probe, both cuvette towers, or even the Peltier element heat exchanger *vs* time. It will also permit you to set up temperature ramps. If you wish to do your own programming, please see the Appendix for communication instructions and the set of text commands that may be used and responses to the commands.

4. ERROR CODES

When errors occur, the line 1 of the display presents an error code. Line 3 of the display identifies the error and line 4 of the display presents possible solutions. The most common events that cause errors to be displayed are loose cables or inadequate coolant flow. For errors not easily solved, please contact us through our website, www.qnw.com.

E5– cell out of range

warnings: loose cable, sensor failure
The temperature controller is not receiving a reasonable response from the sensor on the cuvette tower. Either the sensor has failed or a cable is not making a good connection.

E6 – cell out of range

warnings: loose cable, check cable
The temperature controller is not receiving reasonable responses from either the cell tower or heat exchanger sensors. Since it is very unlikely for both to fail, probably a cable is loose.

E7 – heat exchanger error

warnings: loose cable, sensor failure
The temperature controller is not receiving a reasonable response from the sensor on the heat exchanger. Either the sensor has failed or a cable is not making a good connection.

E8 – inadequate coolant

warnings: inadequate coolant, water temperature
The sensor on the heat exchanger is reading a temperature above 60 °C. Temperature control has been shut down to prevent damage to the Peltier element. Either the water was too warm or the rate of flow was inadequate to draw sufficient heat from the heat exchanger.

*5. **t**2x2 SPECIFICATIONS*

The t2x2 has two cuvette holders that may be controlled together or independently. Each has the following specifications:

temperature range	-20 to +110 °C
temperature precision	±0.05 °C
cuvette size (outside dimensions)	12.5 x 12.5 mm
minimum cuvette height	30 mm
magnetic stirring speed	400 to 1700 rpm
cuvette z height	8.5 or 15 mm (specified when ordering)
optical port dimensions (mask)	10 mm high x 8 mm wide

APPENDIX: SERIAL COMMUNICATIONS FOR THE TC 1 TEMPERATURE CONTROLLER

7/25/11

This document provides the serial communications protocols for version 1.0 of the firmware on the **TC 1** family of controllers used for the ***t*2**, ***t*2x2** and ***turret*6**

The version number and the ID (see below) are shown briefly on the display when the temperature controller is turned on.

All functions of the temperature controller can be managed from a computer, using the command set described below. If you purchased your unit as a component of a spectrometer from certain manufacturers, this feature may be implemented through traditional RS232 serial connectors on the computer or the spectrometer and on the controller. In this case they will be connected by a standard 15-pin serial extension cable (male connector on one end and female on the other). No driver installation should be needed.

Otherwise the serial linkage will be established through a USB connection between the computer and the controller. In this case the controller includes electronics which convert the USB connection to a serial communications port. However, for the port to be available to programs on the computer it will be necessary to load driver software. It is important that the driver software be loaded before connecting a USB cable between the controller and the computer. Contact Quantum Northwest for further information.

Quantum Northwest can provide a control program written specifically for control of all functions of the temperature controller. Ask for program T-App.

In programming for the **TC 1** controller, one must adhere to the conventional notation: 8/N/1.

Baud:	19200
Data Bits:	8
Parity:	None
Stop Bit:	1
Flow Control:	None

For many of the commands listed below the controller returns information in response to the command. All commands and responses are delineated by left and right square brackets ([ ]). Any text sent to the controller not enclosed within brackets will be ignored. In this document an ellipsis (……) is used to distinguish responses from commands.

`[command]`	Purpose of the command (sent to the controller).
`......[response]`	Meaning of the response (received from the controller).

1. <u>Identify</u>

`[F1 ID ?]`	What is the ID number of the sample holder being controlled?
`......[F1 ID 14]`	Sample holder is a **t2** or other single cuvette sample holder.

Assigned Identities:	
ID =	00 – **specialty sample holder**
	14 **– t2**
	24 **– t2x2**
	34 – turret6 or other multi-sample holder

---

2. Controller Firmware Version

`[F1 VN ?]` What is the version number of the controller firmware?

`......[F1 VN 1.00]` The controller is operating firmware version number 1.00.

---

3. Stirrer

`[F1 MS ?]` What is the maximum stirrer speed?

`......[F1 MS 2500]` The maximum stirrer speed is 2500 rpm.

`[F1 LS ?]` What is the lowest stirrer speed?

`......[F1 MS 300]` The lowest stirrer speed is 300 rpm.

`[F1 SS S 1000]` Set stirrer speed to 1000 rpm.

`[F1 SS S 0]` Turn stirrer off and set the speed to zero.

`[F1 SS +]` Turn stirrer on and set it to the most recent non-zero stirrer speed setting.

`[F1 SS -]` Turn stirrer off.

`[F1 SS ?]` What is the current stirrer speed setting?

`......[F1 SS 1000]` Stirrer speed setting is 1000 rpm.

---

4. Temperature Control

`[F1 TC +]` Turn temperature control on.

`[F1 TC -]` Turn temperature control off.

---

5. Target Temperature

`[F1 TT S 23.10]` Set target temperature to 23.10 ºC.

`[F1 TT ?]` What is the current target temperature?

`......[F1 TT 71.32]` Target temperature is 71.32 ºC.

`[F1 TT +]` Turn on automatic reporting of manual changes to the target temperature.

`[F1 TT -]` Turn off automatic reporting of manual changes to the target temperature.

[F1 MT ?]	What is the maximum target temperature allowed?
......[F1 MT 110]	The maximum target temperature allowed is 110 ºC.
[F1 LT ?]	What is the lowest target temperature allowed?
......[F1 LT -30]	The lowest target temperature allowed is -30 ºC.

---

6. Instrument Status

[F1 IS ?]	What is the current instrument status?
......[F1 IS 0-+S]	Response is four parameters: number of unreported errors is 0 (0 to 9) stirrer is off (+ is on, - is off) temperature control is on (+ is on, - is off) temperature is stable (S is stable, C is changing)
[F1 IS +]	Automatically report instrument status whenever it changes (e.g., due to manual changes at the controller)
[F1 IS -]	Stop automatic reports of instrument status.
......[F1 IS R]	The controller has been powered off and back on again.

---

7. Current Sample Temperature

[F1 CT ?]	What is the current temperature of the holder?
......[F1 CT 22.84]	The current temperature is 22.84 ºC.
[F1 CT +3]	Periodically report current temperature every 3 seconds.
[F1 CT -]	Stop periodic current temperature reports.

---

8. Error Reporting

[F1 ER ?]	Report the current error.
......[F1 ER -1]	No current error.
......[F1 ER 05]	Cell T out of range (Loose cable? Sensor failure?).
......[F1 ER 06]	Cell & heat exchanger T out of range (Loose cable?).
......[F1 ER 07]	Heat exchanger T out of range (Loose cable? Sensor failure?).
......[F1 ER 08]	Inadequate coolant (check flow). Temperature control has shut down.
......[F1 ER 09<<bad command>>]	Syntax error on a preceding command where <<bad command>> is the command that caused the syntax error.
[F1 ER +]	Automatically report errors when they occur.
[F1 ER -]	Stop automatic error reports.

---

9. Probe Status and Temperature

`[F1 PS ?]`	Is there an external temperature probe connected?
`......[F1 PR +]`	A probe is connected.
`......[F1 PR -]`	No probe is connected.
`[F1 PS +]`	Enable probe status to be sent automatically when a probe is installed or removed. This is the default.
`[F1 PS -]`	Disable automatic sending of probe status.
`[F1 PT ?]`	What is the current probe temperature?
`[F1 PT +3]`	Periodically report the probe temperature every 3 seconds.
`......[F1 PT 22.3]`	The current probe temperature is 22.3 degrees.
`......[F1 PT NA]`	Probe temperature is not available.
`[F1 PT -]`	Stop periodic probe temperature reports.
`[F1 PA S 0.5]`	Set the increment for automatic reporting of the probe temperature to 0.5 degrees during a ramp. (Increment must be positive, without sign in tenths between 0.1 and 9.9 degrees, and will work for ramps going up or down.)
`[F1 PA +]`	Start automatic reporting of probe temperature every temperature increment (set by the command above).
`......[F1 PT 30.5]`	The current probe temperature is 30.5 degrees.
`[F1 PA -]`	Stop automatic reporting of probe temperature every temperature increment.
`[F1 PX +]`	Change probe temperature returned to a precision of 0.01 degree.

---

10. Temperature Ramping

`[F1 RR S 2.10]`	Set the ramp rate to 2.10 °C/minute.
`[F1 RR ?]`	What is the current ramp rate?
`......[F1 RR 2.10]`	Current ramp rate is 2.10 °C/minute.

For the following three commands, there are no corresponding reference commands ([R1 . . .], see command class 13).

`[F1 TL +]`	Ramp the sample and reference identically.
`[F1 TL -]`	Ramp the sample while the reference remains stable.
`[F1 TL 0]`	Ramp the sample and reference independently.

The default is to ramp the sample while the reference remains stable. Ramping both the sample and reference at different rates or to different target temperatures (see below) is not possible.

To Ramp the temperature:

1. equilibrate at the starting temperature,
2. set the ramp rate,
3. set a new target temperature (command class 5).

The target temperature may be above or below the current temperature; as soon as it is set, the ramp will begin, up or down, to that new target.

After reaching the target, the controller will hold at that temperature. At any time a new ramp rate and target temperature can be set to start a new ramp.

Once you are done, set the ramp rate to 0. Otherwise, setting a new target temperature later will initiate a ramp to that target temperature.

Notes:

The minimum settable ramp rate is about 0.0000001 °C/minute.

For higher ramp settings, the observed rate may be nonlinear over part of the temperature range because the maximum possible rate of heating or cooling is limited .

When the ramping process is completed the controller will send a response of the form [F1 TT #] as a notification of the end of the ramp. This response can be blocked at any time by previously sending the command [F1 TT -] (see command class 5).

---

11. Heat Exchanger Temperature

`[F1 HL ?]`	What is the high temperature limit for the heat exchanger?
`......[F1 HT 60]`	The heat exchanger high temperature limit is 60 ºC.
`[F1 HT ?]`	What is the current temperature of the heat exchanger?
`......[F1 HT 39]`	The current heat exchanger temperature is 39 ºC.
`[F1 HT +3]`	Start periodic heat exchanger temperature reports every 3 seconds.
`[F1 HT -]`	Stop periodic heat exchanger temperature reports.

---

12. Cell Changing

These commands will have an effect only for a sample holder with multiple cuvette positions.

`[F2 MP ?]`	What is the number of positions (maximum position number)?
`...... [F2 MP 6]`	The sample holder has 6 positions.
`[F2 PI]`	Device initialize: move to home, then to position 1 and reply when done.
`......[F2 PL 1]`	Device is in position 1.
`[F2 PL 4]` be	Device locate: move to position 4 and reply when done. (Device should initialized prior to using this command for the first time.)
`......[F2 PL 4]`	Device is now in position 4.
`[F2 PL ?]`	What is the device location (position)?
`......[F2 PL ?]`	Device is moving.
`......[F2 PL 2]`	Device is in position 2. (If reply is 0, device is not initialized.)
`[F2 DD 2]`	Set speed to 2 (acceptable range 2-250 with 2 being fast, 250 being slow).

[F2 DD ?]	What is the current device speed?
......[F2 DD 2]	Device is set to speed setting 2.

---

13. Reference Cuvette

These commands will have an effect only for systems with two independently controlled sample holders.

[R1 ...]

To control and monitor the temperature and status of the reference cuvette using a Dual Temperature Controller, use any commands in classes 3-8, 10 and 11, substituting R1 for F1. There are no corresponding [R1 …] commands for command classes 1, 2, 9 and 12.

If you wish to ramp the temperature of the reference and sample cuvettes together, please note the linking command, [F1 TL +], in command class 10.

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14. Control of Automatic Reports

The TC 1 can be controlled manually using the buttons and the display on the front. When a computer program is in use, the TC 1 will automatically send reports to the program whenever a manual change has been made. The commands in this section are intended to allow the program to prevent the TC 1 from sending those automatic reports.

[F1 XX R(+/-)]	Stop (R-) or start (R+) reporting all manual changes, including those starting with [R1 and [F2. By replacing the XX with individual command codes, a program can selectively stop or start reporting of manual changes.
[F1 SS R-]	Stop reporting manual changes for the sample stirrer.
[F1 TC R-]	Stop reporting manual changes for the sample temperature control.
[F1 TT R-]	Stop reporting manual changes for the sample target temperature.
[F1 PR R-]	Stop reporting manual changes for the external probe connection.
[F1 RR R-]	Stop reporting manual changes for the sample ramp rate.
[F2 PL R-]	Stop reporting manual changes for the sample position.
[R1 SS R-]	Stop reporting manual changes for the reference stirrer.
[R1 TC R-]	Stop reporting manual changes for the reference temperature control.
[R1 TT R-]	Stop reporting manual changes for the reference target temperature.
[R1 RR R-]	Stop reporting manual changes for the reference ramp rate.