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# T100 Thermal Cycler

## Instruction Manual

Catalog #1861096



## Bio-Rad Resources

Bio-Rad provides many resources for scientists. Visit [bio-rad.com/genomics](http://bio-rad.com/genomics) to find useful information for running PCR and real-time PCR experiments. The site includes links to technical notes, manuals, product information, and technical support, as well as a wide variety of methods and applications related to PCR, real-time PCR, and gene expression.

### Bio-Rad Resources

Resource	How to Contact
Local Bio-Rad representatives	Find local information and contacts on the Bio-Rad website ( <a href="http://bio-rad.com">bio-rad.com</a> ). Use the list at the end of this manual to find the nearest international office.
Technical notes and literature	On <a href="http://bio-rad.com">bio-rad.com</a> , use the Search box and click the Documents tab to list technical notes, manuals, and other literature.
Technical specialists	For technical support in the United States and Canada, call 1-800-424-6723 (toll-free), and select the technical support option. To find local technical support on the phone, contact your nearest Bio-Rad office.

## Warranty

The T100 Thermal Cycler and associated accessories are covered by a standard Bio-Rad warranty. Contact your local Bio-Rad office for details.

## Writing Conventions Used in This Manual

This manual provides instructions on how to safely set up and operate the T100 Thermal Cycler and uses the writing conventions shown in this table to quickly provide relevant information.

### Writing Conventions in This Manual

Convention	Meaning
<b>Tip</b>	Provides helpful instructions, including information explained in further detail elsewhere in this manual
<b>Note</b>	Provides important information, including information explained in further detail elsewhere in this manual
<b>WARNING!</b>	Explains crucial information about a topic that may lead to injury to the user, instrument damage, or data loss
Touch <b>X</b>	Touch a button on the screen using your finger. For example, "Touch <b>New Protocol</b> " means use your finger to touch the <b>New Protocol</b> button on the screen
Touch <b>X &gt; Y</b>	From a menu, touch an option. For example, touch <b>Tools &gt; About</b> means touch the <b>Tools</b> button, then touch <b>About</b> from the <b>Tools</b> menu





## Safety and Regulatory Compliance

The T100 Thermal Cycler heats and cools very quickly during operation. Bio-Rad strongly recommends that you follow the safety specifications listed in this section and throughout this manual.

## Safety Warning Labels

Warning labels posted on the instrument and in this manual warn you about sources of injury or harm. Refer to the table to review the meaning of each safety warning label.

### General Safety Warnings

Icon	Warning	Meaning
	<b>CAUTION: Risk of danger!</b> This symbol identifies components that pose a risk of personal injury or damage to the instrument if improperly handled. Wherever this symbol appears, consult the manual for further information before proceeding.	<b>Warning about risk of harm to body or equipment.</b> Operating the T100 instrument before reading this manual can constitute a personal injury hazard. The use of this instrument in a manner not specified in this manual or by Bio-Rad may result in the protection features of the instrument becoming impaired or disabled.
	<b>CAUTION: Risk of electrical shock!</b> This symbol identifies components that pose a risk of electrical shock if improperly handled.	<b>Warning about risk of harm to body or equipment from electrical shock.</b> Do not attempt to repair or remove the outer case of this thermal cycler, power supply, heat pump, or other accessories. This thermal cycler uses neutral fusing, which means that live power could still be exposed inside the instrument even when the fuse is blown or removed. If you open these instruments, you put yourself at risk for electrical shock and void your warranty. All repairs must be done by an authorized repair service.
	<b>CAUTION: Hot surface!</b> This symbol identifies components that pose a risk of personal injury due to excessive heat if improperly handled.	<b>Warning about risk of burning.</b> The T100 Thermal Cycler operates at temperatures high enough to cause serious burns. Always allow the reaction block to return to room temperature before opening the lid and removing samples. Even after the reaction block has cooled, the surrounding areas as well as the heater plate can remain hot for a significant time. In situations where there is not sufficient time to allow the instrument to cool, the use of protective equipment such as thermal gloves or "oven mitts" is recommended.
	<b>CAUTION: Risk of explosion!</b> This symbol identifies components that pose a risk of personal injury due to explosion if improperly handled.	<b>Warning about risk of explosion.</b> The T100 instrument can become hot enough during the course of normal operation to cause liquids in the samples to boil or vaporize, pressurizing the sample containers. There is the possibility that the sample container(s) could fail, leading to leaks, fluid spray, or explosive rupture and expulsion of vapors or liquids in and around the instrument. Users should always operate the instrument with the lid closed or wear safety goggles, thermal gloves, and other personal protection equipment during operation to avoid injury. Opening the instrument while samples are still hot, such as after aborting a run, can allow pressurized containers to leak, spray, or spurt liquid. Always allow the samples to cool before opening the lid. Users should never run a reaction with a lid or seal that is open, loose, punctured, or otherwise damaged because it will increase the likelihood of a dangerous rupture or explosion. Users should never run a reaction with volatile reagents that could increase the likelihood of a dangerous rupture or explosion.

## Safety and Regulatory Compliance

This instrument has been tested and found to be in compliance with all applicable requirements of the following safety and electromagnetic standards.

### Safe Use Specifications

Usage Aspect	Conditions for Safe Use
Rated input power	100–240 VAC, 50–60 Hz, 700 W max
Mains supply voltage fluctuations	±10%
Overvoltage category	II
Replacement fuses	10 A, 250 V, 5 x 20 mm, fast blow (qty 2)
Environment	Indoor use only
Operating temperature range	15–31°C
Relative humidity	Up to 80% (noncondensing)
Elevation	Up to 2,000 m above sea level
Pollution degree	2

## **Safety Compliance**

This instrument has been tested and found to be in compliance with all applicable requirements of the following safety and electromagnetic standards:

- IEC 61010-1:2010. Safety requirements for electrical equipment for measurement control, and laboratory use — Part 1: General requirements.
- IEC 61010-2-010:2014. Safety requirements for electrical equipment for measurement, control, and laboratory use — Part 2-010: Particular requirements for laboratory equipment for the heating of material.
- CAN/CSA C22.2 No. 61010-1-12+G11+G12 (2017). Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use — Part 1: General Requirements.
- CAN/CSA C22.2 No. 61010-2-010:2019. Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use — Part 2-010: Particular Requirements for Laboratory Equipment for the Heating of Materials.
- EN 61010-1:2010. Safety requirements for electrical equipment for measurement, control, and laboratory use — Part 1: General requirements.
- EN 61010-2-010:2019. Safety requirements for electrical equipment for measurement, control, and laboratory use — Part 2-010: Particular requirements for laboratory equipment for the heating of material.
- UL 61010-1:2012(R7.19). Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use — Part 1: General Requirements.
- UL 61010-2-010:2019. Standard for Electrical Equipment for Laboratory Use; Part 2: Particular Requirements for Laboratory Equipment for the Heating of Material.

## **Electromagnetic Compatibility (EMC)**

- IEC61326-1:2005. Electrical Equipment for measurement, control, and laboratory use — EMC Requirements, Class A.
- EN61326-1:2006. Electrical Equipment for measurement, control, and laboratory use — EMC Requirements, Class A.
- FCC Part 15, Subpart B, Sections 15.107 and 15.109 as a Class A digital device.

## **FCC Warnings and Notes**

**WARNING!** Changes or modifications to this unit, not expressly approved by Bio-Rad Laboratories, could void the user's authority to operate the equipment.

**Note:** This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at the user's own expense.

**Note regarding FCC compliance:** Although this instrument has been tested and found to comply with Part 15, Subpart B of the FCC Rules for a Class A digital device, note that this compliance is voluntary, for the instrument qualifies as an "exempted device" under 47 CFR 15.103(c), in regard to the cited FCC regulations in effect at the time of manufacture.

**Note regarding Canadian EMC compliance:** Le present appareil numerique n'emet pas de bruits radioelectrique depassant les limites applicables aux appareils numeriques de class A prescrites dans le reglement sur le brouillage radioelectrique edicte par le Ministere des Communications du Canada.

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# Chapter 1

## Introduction to the T100 Thermal Cycler

### System Overview

The T100 Thermal Cycler has a 96-well block that is compatible with standard height tubes, tube strips, and plates. It can run sample volumes of 1–100  $\mu\text{l}$ , with volumes of 15–100  $\mu\text{l}$  recommended for the best reproducibility. It is composed of the following parts:

- **Reaction block** — holds the plates, tubes, or tube strips containing samples
- **Heated inner lid** — heats the top of the samples to prevent evaporation and condensation
- **Touch screen** — provides the means to control the cycler with gloved or ungloved hands
- **USB port** — connects to a USB flash drive for data transfer
- **Status LED** — turns on during normal operation; blinks when the cycler is in standby
- **Air vents** — provide ventilation to allow the thermal cycler to heat and cool quickly



Fig. 1. Front view of the T100 Thermal Cycler.

## Instrument Specifications

Table 1 in this section lists the instrument specifications for the T100 Thermal Cycler.

**Table 1. T100 Thermal Cycler specifications.**

Item	Specification
Sample capacity	96 x 0.2 ml tubes, 0.2 ml tube strips, or 1 x 96-well plate
Volume	1–100 $\mu$ l (15–100 $\mu$ l recommended)
Maximum ramp rate	4°C/sec
Average ramp rate	2.5°C/sec
Lid temperature	40–110°C
Heating and cooling method	Peltier
Temperature range	4–100°C
Gradient capability	Yes
Gradient operational range	30–100°C
Temperature differential range	1–25°C
Temperature accuracy	$\pm$ 0.5°C of programmed target
Temperature uniformity	$\pm$ 0.5°C well-to-well within 30 sec of arrival at target temperature
Dimensions (W x D x H)	26 x 47 x 23 cm
Weight	9 kg
Memory	500 typical programs; unlimited with USB flash drive expansion
Temperature control modes	Calculated and block
Programming options	Step-base graphical
Reporting	Exportable run logs and system logs
Port	1 USB A
Display	5.7 in. VGA color touch screen

## Setting Up the T100 Thermal Cycler

The T100 Thermal Cycler package includes:

- T100 Thermal Cycler
- Power cord
- Support ring for individual tubes
- Instruction manual

Remove all packaging materials and store them for future use. If any item is missing or damaged, contact your local Bio-Rad office.

Place the T100 Thermal Cycler base on a flat, dry surface with sufficient cool airflow to run properly.

1. Before operating the thermal cycler, be sure to read the safety specifications (Safety and Regulatory Compliance, on page ii) and operating requirements.
2. Plug the supplied power cord into the appropriate electrical outlet.
3. Turn on the thermal cycler using the power switch on the back panel.
4. The thermal cycler runs a self-test to verify proper function, and then displays the home screen.

## Home Screen Overview

The home screen provides access to all the main functions of the thermal cycler (Figure 2), as well as the date, time, and name of the thermal cycler (optional).



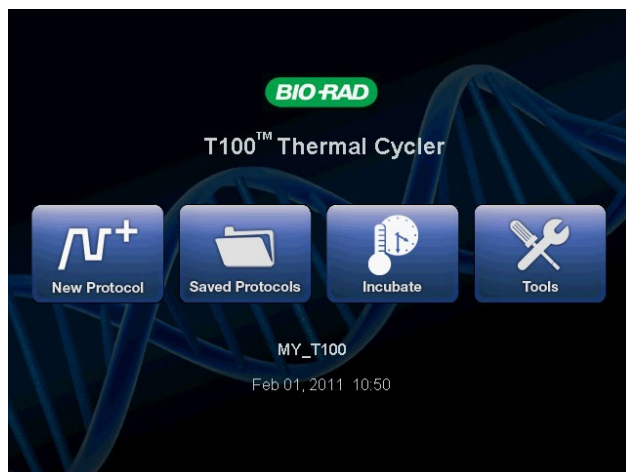


Fig. 2. The home screen of the T100 Thermal Cycler.

To initiate the functions in the home screen, touch the button for each function:

- **New Protocol** — creates a new protocol (page 5)
- **Saved Protocols** — for viewing, editing, and running saved protocols (page 18)
- **Incubate** — for running at a constant temperature similar to an incubator (page 16)
- **Tools** — logs, settings, self-test, system information, and firmware update (page 20)

## Loading Samples

The inner lid of the reaction module applies heat and force to the reaction vessel lids (caps or sealing film). Heating the inner lid prevents condensation, and applying force seals the reaction to prevent evaporation.

**WARNING!** After a run, the heated inner lid can remain hot. Use caution when opening and closing the lid.

1. To open the lid, lift up the lid handle until the lid stays open without assistance (Figure 3).



Fig. 3. Lift the lid handle up to open the lid.

## 2. Load the samples.

To ensure uniform heating and cooling of samples, vessels must be in complete contact with the reaction block. Adequate contact is achieved by:

- Confirming that the block is clean before loading samples
- Firmly pressing the individual tubes or the microplate into the block wells

**Note:** When running individual tubes, place the support ring in the block to prevent deformation of the tubes by the heated lid. The ring is reversible for domed cap tubes or flat cap tubes (Figure 4). Alternatively, load 8 empty tubes in the corners and sides of the block.

## 3. To close the lid, push the lid handle down until it stops.

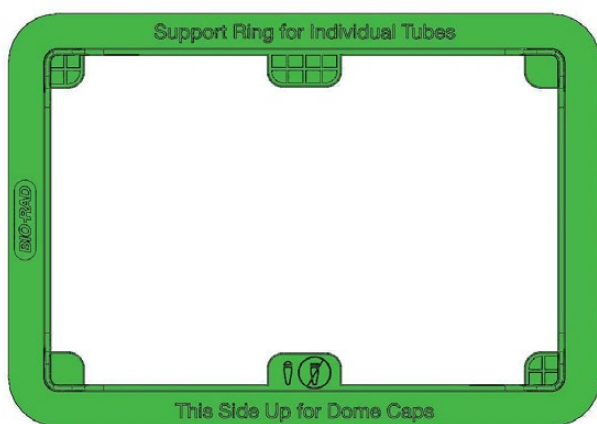


Fig. 4. Tube support ring for running individual tubes.

## Compatible Reaction Vessels and Sealing Options

The T100 Thermal Cycler is compatible with full-height strips, tubes, and plates. Bio-Rad tests the standard supplies listed in Table 2 for compatibility with the T100 Thermal Cycler.

The composition and thickness of reaction vessels influence the outcome of a reaction. Microplates, tubes, sealers, and caps come in a variety of compositions and colors. For a full list of available reagents and supplies, refer to the Life Science Research Product Catalog or the website at [bio-rad.com/PCRReagentSelector](http://bio-rad.com/PCRReagentSelector).

**Table 2. Compatible microplates, tubes, and sealing options for the T100 Thermal Cycler.**

Tubes and Microplates		Caps and Sealers	
Description (Catalog Prefix*)	Volume and Number	Description (Catalog Prefix*)	
<b>Tubes</b>		<b>Caps (TCS*)</b>	
Individual tubes with caps (TFI* and TWI*)	0.2 ml	(Included)	
Strip tubes (TBS*)	0.2 ml, 8-and 12-tube	Strip	
<b>Microplates</b>		<b>Film (MS*)</b>	<b>Caps (TCS*)</b>
Unskirted and full height (MLP*)	96-well	A, B, F	Strip
iQ full-height plates (2239441)	96-well	A, B, F	Strip
Semi-skirted, full-height, and Hard-Shell Plates (HSS*)	96-well	A, B, F	Strip

\* The prefix of the catalog number for each series of supplies.

Go to [bio-rad.com/PCRPlasticSelector](http://bio-rad.com/PCRPlasticSelector) and use our interactive selection tool to find the PCR plastics that fit your instrument.

## Chapter 2

# Creating, Editing, and Saving Protocols

### Creating a New Protocol or Editing an Existing Protocol

To create or edit a protocol:

1. To create a new protocol, touch **New Protocol** from the home screen.
2. Alternatively, to edit an existing protocol, touch **Saved Protocols** from the home screen, select the protocol to be modified, and touch Edit (Figure 5).
3. The protocol editing screen opens (Figure 6).



Fig. 5. Select a protocol, then touch Edit.

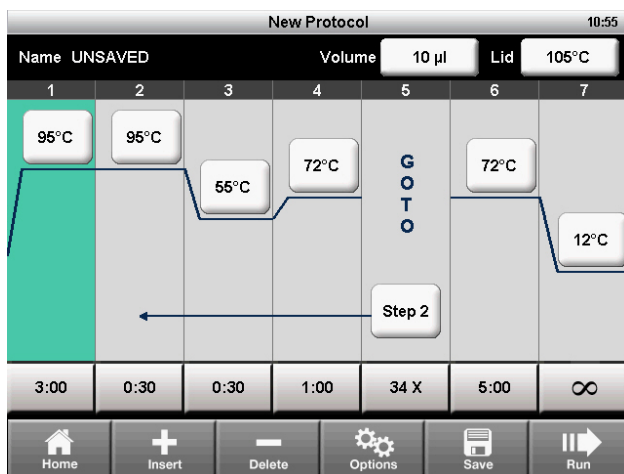


Fig. 6. The template for a PCR protocol.

4. The protocol editor displays the protocol in a graphical format using editable boxes.
5. To edit the temperature or time for each step, the sample volume, and the lid temperature, touch the appropriate box and enter a new value with the numeric keypad.
6. Touch **Run** to run the protocol immediately without saving it. Alternatively, touch **Save** to choose a folder location and save the protocol, and then touch **Run** to run it (page 13).

## Protocol Parameters

Table 3 includes a list of all the parameters for temperature and gradient steps.

**Table 3. Protocol steps and parameters of the T100 Thermal Cycler.**

Step Name	Parameters and Ranges	Description
<b>Temperature</b>	<b>Temperature in °C:</b> The target temperature between 4.0 and 100.0°C in tenths of a degree	Instructs the thermal cycler to ramp to the target temperature and hold that temperature for a specified time
<b>Time</b>	The hold time between 1 sec and 18 hr in the format of hr:min:sec. To enter an infinite hold, touch the ∞ (infinity, 0) key	
<b>Gradient</b>	<b>Front row:</b> The lower temperature in the gradient. Enter a number between 30.0 and 99.0°C in tenths of a degree <b>Back row:</b> The upper temperature in the gradient. The maximum temperature is 100°C. Enter a temperature within 25.0°C of the lower temperature	Instructs the thermal cycler to ramp to the target temperature gradient across the block and hold that temperature gradient or a specified time
<b>Increment</b>	A temperature from -10.0 to 10.0°C per cycle in tenths of a degree	Applies only to a temperature step. Instructs the thermal cycler to increment (change) the target temperature of a step with each cycle, where a positive number increases the temperature and a negative number decreases the temperature
<b>Ramp Rate</b>	A number from 0.1 to 4°C per sec	Applies only to a temperature step. Instructs the thermal cycler to ramp to the target temperature at the specified ramp rate in that step. If not specified, the T100 Thermal Cycler runs at a maximum ramp rate of 4°C/sec
<b>Extend</b>	A time from -60 to 60 sec per cycle	Applies to both temperature and gradient steps. Instructs the thermal cycler to extend the hold time with each cycle. A positive number increases the hold time and a negative number decreases the hold time

## Changing Target Temperature and Hold Time

To change the target temperature and hold time in a temperature step:

1. From the protocol editor, touch the temperature or hold time for a step.
2. A pop-up keypad appears and allows you to edit the value (Figure 7).
3. Enter a new value, then touch **OK**.



Fig. 7. Editing a temperature with the numeric keypad.

## Inserting a Protocol Step

Insert a protocol step if a new temperature, GOTO, or gradient step is needed:

1. Select a step to the left of where the new step is to be inserted.
2. Touch **Insert**. A pop-up menu displays types of steps to insert (Figure 8).



Fig. 8. Insert a new step to the right of step 1.

3. Touch **Temperature** to insert a temperature step, **Gradient** to insert a gradient step, or **GOTO** to insert a GOTO step to create a cycle for PCR.
4. Edit the parameters in the new step as desired.

## Deleting a Protocol Step

To remove a step from a protocol:

1. Select the step to be deleted.
2. Touch **Delete** to remove the selected step.

## Adding or Removing a Temperature Gradient

To add a temperature gradient to a step:

1. Select a step, then touch **Options** to open the **Step Options** window (Figure 9).

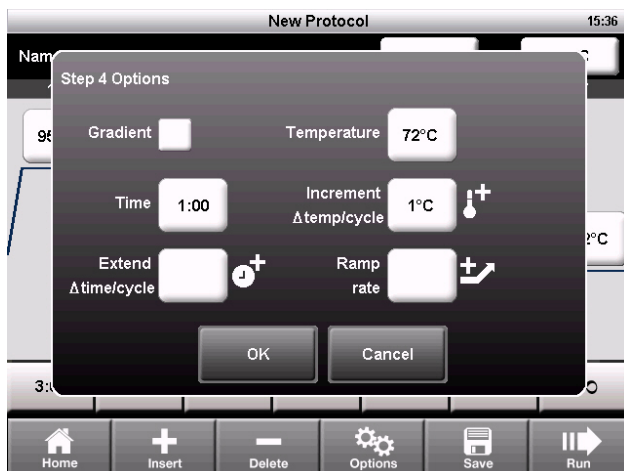


Fig. 9. The Step Options window.

2. Select the **Gradient** checkbox. The temperatures for each row are displayed (Figure 10).
3. Touch the **Back Row** and **Front Row** fields to edit the gradient, and touch **OK**.

**Note:** A gradient range must be between 1 and 25°C.

**Note:** A gradient step can also include an **Extend** parameter, but the **Increment** and **Ramp Rate** options are not allowed.

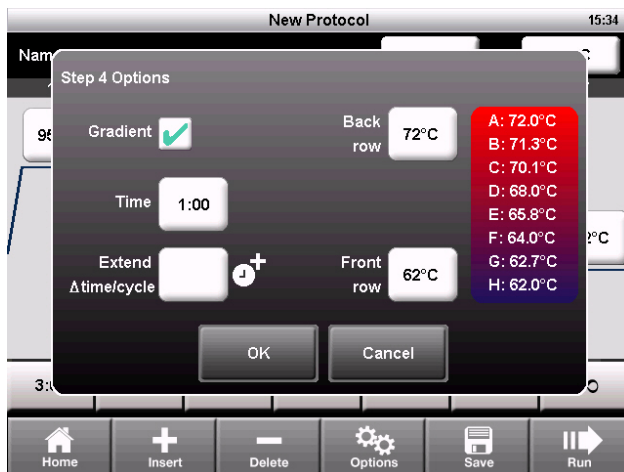


Fig. 10. The Step Options window displays the gradient temperatures.

4. The front and back row temperatures of the gradient are displayed as two lines in the thermal profile (Figure 11).
5. The gradient can be edited by touching the temperatures directly without opening the **Step Options** screen.

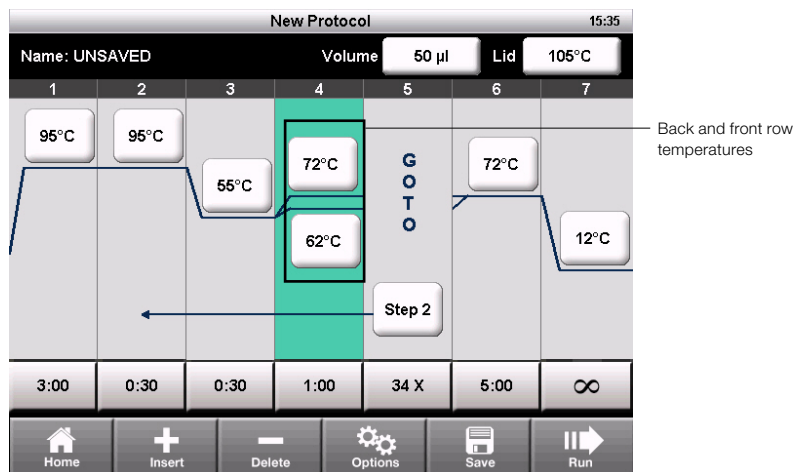


Fig. 11. The protocol has a gradient from 62 to 72°C.

To remove the temperature gradient:

1. Select the gradient step, then touch **Options** to open the **Step Options** window.
2. Deselect the **Gradient** checkbox.
3. Select **OK** to confirm.

## Temperature Increment, Extend, and Ramp Rate

To add increments, extensions, and ramp rates to a step:

1. Select a step, then touch **Options** to open the **Step Options** window (Figure 12).
2. A step can contain all three options. To edit an option, touch the field for **Increment**, **Extend**, or **Ramp rate**.
3. Enter a value using the numeric keypad, then touch **OK**.

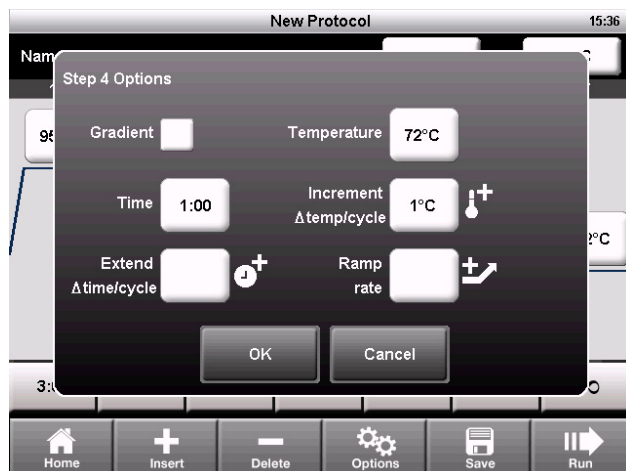


Fig. 12. Step 4 has a temperature increment option.

To remove the increment, extension, or ramp rate:

1. From the **Step Options** window, touch the field for the option and change the value to zero using the numeric keypad.
2. Touch **OK** to confirm.

## Changing Parameters in a GOTO Step

The GOTO step instructs the thermal cycler to repeat a set of steps in a cycle. To edit the GOTO step:

1. Select a **GOTO** step.

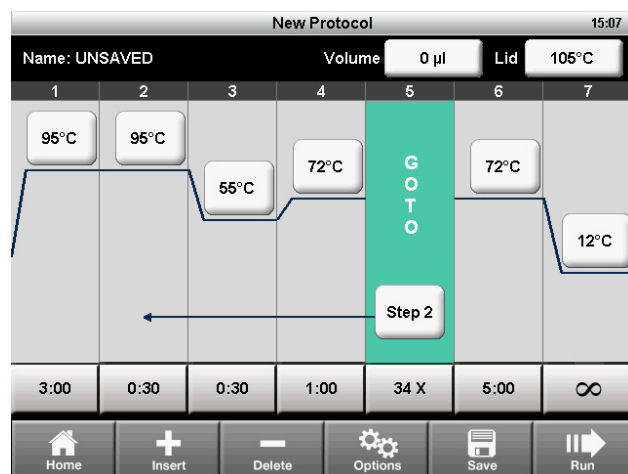


Fig. 13. A protocol that includes a GOTO step 2 and 34 additional repeats.

2. To change the step that the cycler will start repeating, touch the **Step** field.
3. Enter a value for the first step in the GOTO loop using the numeric keypad, then touch **OK**.
4. To change the number of times the cycler will repeat the cycle, touch the **X** field.
5. Edit the number of repeats using the numeric keypad, then touch **OK**.

**Note:** The **X** field is the number of additional repeats. For example, 34 X will repeat steps 2–4 an additional 34 times for a total of 35 cycles of PCR.

**Note:** A protocol may contain multiple GOTO loops, but they may not be nested with one loop inside another.

## Sample Volume and Lid Temperature

- **Sample volume** — determines the temperature control mode, which influences the amount of time the samples are held at the target temperature
- **Lid temperature** — determines the temperature of the heated lid



The T100 Thermal Cycler provides three ways to enter sample volume and lid temperature:

- Change the setting when creating and editing the protocol (page 12)
- Override the sample volume setting while initiating a run (page 13)
- Set a default for the sample volume for new protocols in Settings (page 20)

## Temperature Control Modes

The T100 Thermal Cycler uses one of two temperature control modes to determine when the sample reaches the target temperature:

- **Calculated mode** — the thermal cycler calculates the sample temperature based on the sample volume when a sample volume between 1 and 100  $\mu\text{l}$  is entered
- **Block mode** — when a sample volume of zero (0)  $\mu\text{l}$  is entered, the thermal cycler assumes that the sample temperature is the same as the measured block temperature

## Changing Sample Volume

To change the sample volume for a protocol:

1. From the **New Protocol** screen, touch the **Volume** field.
2. Using the numeric keypad, enter the sample volume, then touch **OK**.
3. Entering a sample volume between 1 and 100  $\mu\text{l}$  selects Calculated mode. Entering a sample volume of **zero (0)** selects Block mode. Calculated mode is the recommended mode because it most accurately represents the actual sample temperature.

## Changing Lid Temperature

Heating the lid prevents condensation from forming inside the reaction wells. Without a heated lid, water can be lost to condensation, concentrating the reactants in the tube or plate.

The T100 Thermal Cycler lid can be programmed to heat between 40 and 110°C. The default recommended lid temperature is 105°C.

**Note:** When the block is running an infinite hold at a temperature below the cutoff temperature of 30.0°C, the lid heater maintains 31.0°C.

To change the lid temperature:

1. From the **New Protocol** screen, touch the **Lid** field.
2. Using the numeric keypad, enter the lid temperature, then touch **OK**.

## Saving a Protocol

To save a new or modified protocol:

1. From the **New Protocol** screen, touch **Save**.
2. Name the protocol by typing a name up to 8 characters using the alphanumeric keypad (Figure 14).  
**Note:** Saving the protocol with the same name replaces the original protocol. Saving the protocol with a new name adds a new protocol and does not affect the original protocol.
3. Select the destination folder in which to save the protocol from the dropdown box. The default location is the MAIN folder. Alternatively, touch the new folder icon to save the protocol in a new folder.
4. Touch **Save** to save the protocol and return to the **New Protocol** screen.



Fig. 14. The protocol is saved as STDGRAD in the EVA folder.

## Chapter 3

# Running Protocols

### Starting a Run

To start a run, use one of the following methods:

- Create a new protocol, and then touch **Run**
- Select a protocol from the **Saved Protocols** screen, and then touch **Run**
- Select a protocol from the **Saved Protocols** screen, touch **Edit**, make the changes, and then touch **Run**

To run a protocol, follow these steps:

1. To run a saved protocol, touch **Saved Protocols** from the home screen (Figure 15).



Fig. 15. The ISCRIP protocol selected from the Saved Protocols screen.

The **Saved Protocols** screen is organized into three panes:

- The **Folders** pane displays all folders on the instrument and the USB flash drive if a USB flash drive is connected
- The **Files** pane displays all the protocol files in the selected folder
- The **Preview** pane displays a preview of the selected protocol file

To select and run a specific protocol:

2. Touch any folder to view the protocols in the folder.
3. Touch any protocol to view a preview of the protocol.
4. Touch **Run**. The instrument confirms the run and the sample volume (Figure 16).
5. Touch **OK** to run the protocol, or touch **Volume** to edit the sample volume.



Fig. 16. The run confirmation window.

6. The **Status** screen opens (Figure 17). The run progress can be monitored in two views:
  - **Status** — a graphical view of the protocol and the current step in progress (Figure 17)
  - **Clock** — a large display of the time remaining for convenient monitoring (Figure 18)
7. Touch **View Status** or **View Clock** to toggle between the two views:

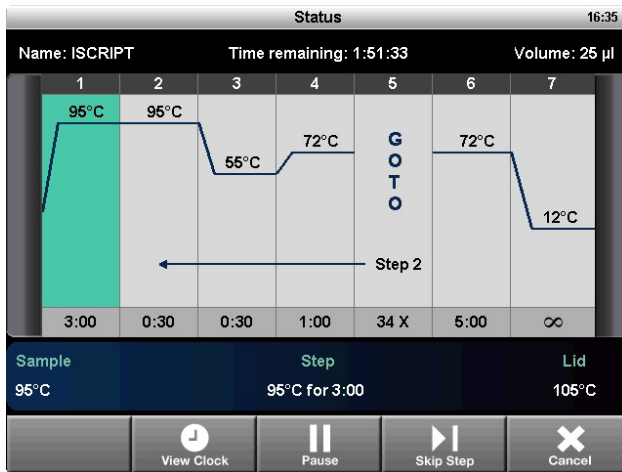


Fig. 17. The Status screen.



Fig. 18. The Clock screen.

## Pausing and Resuming a Run

A running protocol can be paused temporarily. During a pause, the thermal cycler maintains the block temperature of the current step and the lid temperature until the run is resumed. If it is paused during ramping, then it will continue ramping until it reaches the target temperature of the current step.

**Tip:** After a power failure, the T100 Thermal Cycler automatically resumes a run and displays a warning message when the cycler turns back on.

To pause and then resume a running protocol, follow these steps:

1. Touch **Pause** from the **Status** screen.
2. To resume the protocol, touch **Resume** (Figure 19).

**WARNING!** Pausing a step can adversely change the outcome of the experiment. If the protocol is paused during a temperature step, the reactions are held at the target temperature for longer than the protocol requires.

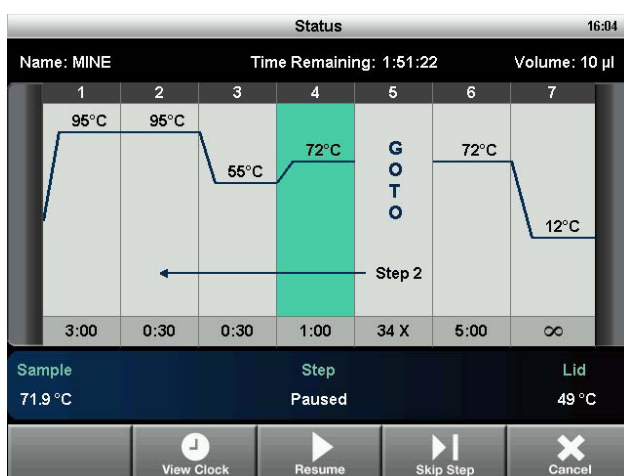


Fig. 19. The running protocol is paused at step 4.

## Skipping Steps in a Protocol

Skip a step if it is necessary to shorten a protocol while it is still running. By repeatedly skipping steps, it is possible to bypass several GOTO loops and shorten a protocol.

To skip the current protocol step, follow these steps:

1. View the current step from the **Status** screen.
2. Touch **Skip Step** to bypass the current step.
3. Touch **Skip Step** multiple times to skip more than one step.

## Canceling a Run

A protocol may be canceled while it is running. When the protocol is canceled, the block immediately stops changing temperature.

**Note:** Do not turn the thermal cycler off immediately after canceling a run. The fans may need to run to cool the block.

To cancel a protocol:

1. Touch **Cancel** from the **Status** screen, and touch **Yes** to confirm.

## Incubating Samples

To incubate samples at a constant temperature for any amount of time:

1. Touch **Incubate** from the home screen. The **Incubate** screen opens (Figure 20).

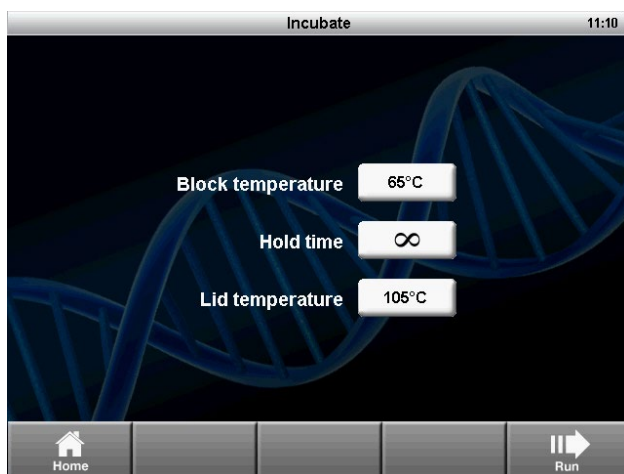


Fig. 20. The Incubate screen.

**Note:** When incubation is occurring at temperatures below 30°C, the lid will maintain a temperature of 31°C to prevent excessive condensation.

2. Edit the **Block temperature**, **Lid temperature**, and **Hold time** parameters.
3. Touch **Run** to start the incubation.
4. To end the incubation, select **Cancel**.

**WARNING!** Incubating samples for extended periods of time at 4–10°C, particularly in areas of high humidity, can cause excessive moisture condensation around the block.

## Chapter 4

# Managing Protocol Files and Folders

### Saved Protocols Overview

To open the screen, touch **Saved Protocols** from the home screen (Figure 21). It contains:

- **MAIN** folder — a library of standard preinstalled protocols for common types of reactions. These protocols can be edited, deleted, or renamed as desired
- **RECENT** folder — a read-only list for quick access to the previous 20 protocols run
- **CUSTOM** folders (optional) — can be created for personal protocol storage
- **USB** folders (optional) — contain the data on an attached USB flash drive

**Note:** The **MAIN** and **RECENT** folders cannot be deleted or renamed.



Fig. 21. The Saved Protocols screen of the T100 Thermal Cycler.

### Creating a New Folder

To create a new folder:

1. From the **Saved Protocols** screen, touch **Folder Options > New** (Figure 22).



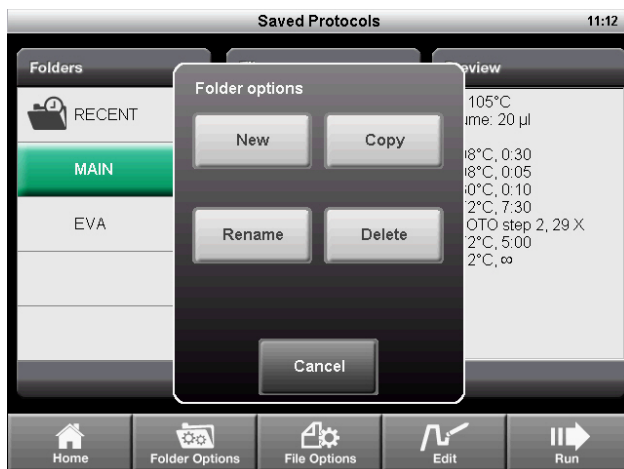


Fig. 22. Touch New to create a new folder on the cyclor.

2. Enter a name up to eight characters using the alphanumeric keypad, and touch **OK**.

## Copying a Folder or File

To create a copy of a folder or protocol file on the cyclor or an attached USB flash drive:

1. Select the folder or file to be copied from the **Saved Protocols** screen.
2. Touch **Folder Options > Copy** to copy a folder or **File Options > Copy** to copy a protocol file (Figure 22).
3. Select where to copy, and touch **Save** to confirm.

## Deleting a Folder or File

To delete a folder or protocol file:

1. Select the folder or file to be deleted from the **Saved Protocols** screen.
2. Touch **Folder Options > Delete** to delete an entire folder or **File Options > Delete** to delete a single protocol file (Figure 22).
3. Touch **Save** to confirm.

## Renaming a Folder or File

To rename a folder or protocol file:

1. Select the folder to be renamed from the **Saved Protocols** screen.
2. Touch **Folder Options > Rename** to rename a folder or **File Options > Rename** to rename a protocol file.
3. Enter a new name in the text box.
4. Touch **OK** to confirm.

## Chapter 5 Tools

### Tools Menu

To access the **Tools** menu, touch **Tools** from the home screen (Figure 23).

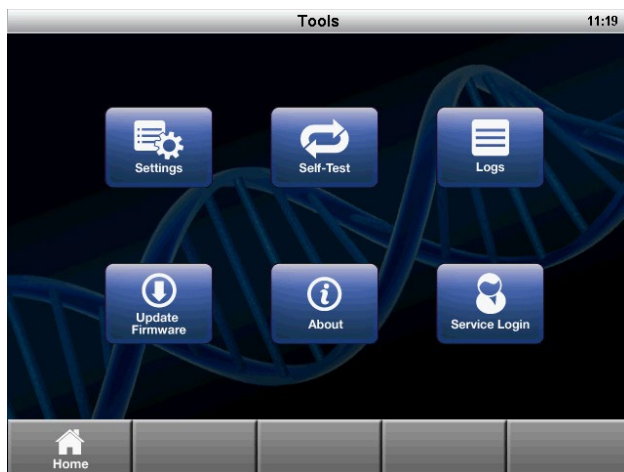


Fig. 23. The Tools menu.

### Settings Menu

The **Settings** menu contains all the functions needed to set system defaults for the T100 Thermal Cycler (Figure 24). Open this list by selecting **Settings** under the **Tools** menu.

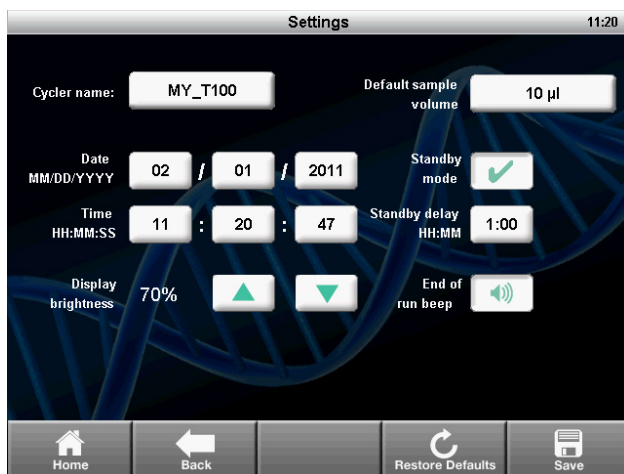


Fig. 24. The Settings menu.

The **Settings** menu contains these options:

- **Date/Time** — for setting the date and time on the thermal cycler
- **Cyclor name** — for personalizing the T100 Thermal Cycler
- **Display brightness** — for adjusting the brightness of the display for different laboratory lighting conditions

- **Default sample volume** — the default sample volume for each new protocol
 

**Note:** When the default sample volume is changed, the sample volume in existing saved protocols remains the same. This setting changes only the default sample volume for new protocols.
- **Standby mode** — for turning the standby mode on or off. Standby mode reduces energy usage by turning off the display and the system fans. Touch the screen to exit standby mode.
- **Standby mode delay** — for configuring the delay before the instrument enters power-saving standby mode
- **End of run beep** — optional setting to emit a sound to notify when the run is completed

To edit the date, time, cyclor name, standby mode delay, or default sample volume:

1. Touch the field to edit.
2. Enter a new value using the keypad, and touch **OK**.
3. Touch **Save** to save the changes.

Edit the other settings as follows:

1. Touch the up and down arrows to adjust the display brightness.
2. Touch the **End of run beep** button to enable or disable the beep sound when a run is completed.
3. Toggle the **Standby mode** checkbox to turn standby mode on or off.

**Note:** Touch **Restore Defaults** to restore the instrument to its factory-installed default settings.

## Self-Test Function

The self-test function performs a diagnostic test of the operation of the T100 Thermal Cycler. To initiate the self-test:

1. From the home screen, open the **Tools** menu.
2. Touch **Self-Test**.
3. Touch **Start** (Figure 25).

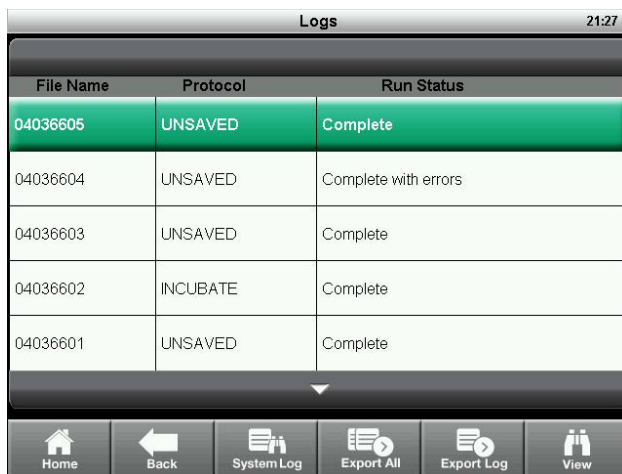


Fig. 25. Self-Test function in progress.

## Logs

The **Logs** screen displays the previous history of the T100 Thermal Cycler for record keeping.

1. Touch **Tools > Logs**. The instrument displays a list of all the previous runs (Figure 26).
2. Select a run, then touch **View**. The details of the selected run are displayed.
3. To view the system log, touch **System Log** from the **Logs** screen. The system log is a summary containing all errors in previous runs such as power failures and other issues.
4. Touch **Export Log** to export the selected log to a USB flash drive, or touch **Export All** to export all the logs.



File Name	Protocol	Run Status
04036605	UNSAVED	Complete
04036604	UNSAVED	Complete with errors
04036603	UNSAVED	Complete
04036602	INCUBATE	Complete
04036601	UNSAVED	Complete

Fig. 26. List of the run logs stored on the instrument.

## Update Firmware

To update the firmware for the T100 Thermal Cycler:

1. Locate the most recent firmware files.
 

**Tip:** Firmware update files are posted at [bio-rad.com/PCRUupdates](http://bio-rad.com/PCRUupdates)
2. Copy the most recent firmware update files onto a USB flash drive.
 

**Note:** Copy the firmware file to the root of the USB flash drive, not into a folder.
3. Insert the USB flash drive into the USB port on the front of the T100 Thermal Cycler.
4. Open the **Tools** menu.
5. Touch **Update Firmware** (Figure 27).
6. Touch **Start** to initiate the firmware update.
 

**Note:** Do not turn off the instrument while the firmware update is in progress.



Fig. 27. Updating the instrument firmware.

## About

The **About** screen displays the firmware version and total hours run. To view the **About** screen:

1. Open the **Tools** menu.
2. Select **About** (Figure 28).

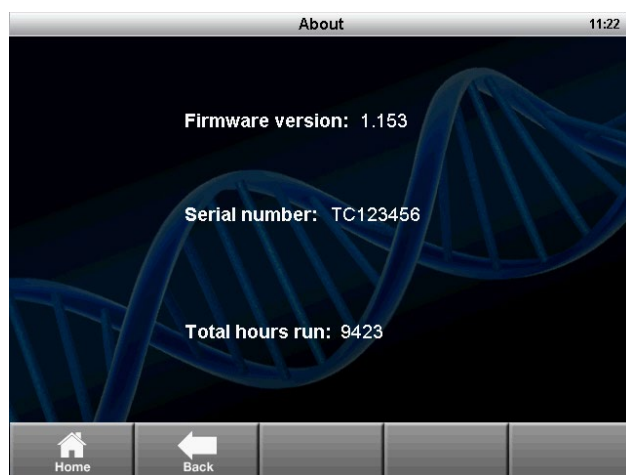


Fig. 28. The About screen.

## Chapter 6

# Maintenance and Cleaning

### About Maintenance and Cleaning

The T100 Thermal Cycler requires little maintenance for proper operation. However, with long and constant use, the thermal cycler requires some cleaning and other maintenance.

For instructions on handling and cleaning radioactive or biohazardous materials, consult the guidelines for radiation safety and biosafety provided by your institution. These guidelines include cleaning, monitoring, and disposal methods for hazardous materials.

**WARNING!** To prevent electrical shock, always turn off and unplug the instrument before cleaning it.

### Cleaning the Exterior of the T100 Thermal Cycler

The T100 Thermal Cycler exterior should be cleaned on a regular schedule to remove any debris or dirt that might interfere with proper function.

To clean the exterior of the thermal cycler, follow these instructions and pay careful attention to the warnings:

- **Clean the air vents.** Remove dust with a soft brush, damp cloth, or vacuum cleaner. Remove any heavy dust that is deep in the vents with a vacuum cleaner. Cleaning the vents allows sufficient airflow for precise thermal control during a run
- **Clean the touch screen.** Remove debris on the control panel with a soft cloth and any commercial touch screen cleaning fluid or mild soap solution

**WARNING!** Do not use abrasive detergents or rough material; they will scratch the display.

- **Clean the outside case and lid of the thermal cycler.** Use a damp cloth or tissue to clean spills off the outside case. If needed, use a mild soap solution, and remove the residue completely. Cleaning the outside case prevents corrosion
- **Clean the inner heated lid.** Use a soft cloth and water to remove debris and solutions from the inner lid surface. Never use abrasive detergents or rough material that can scratch the surface. Cleaning the inner lid improves precise sample heating and cooling

### Cleaning the Reaction Block

Clean the reaction block of the T100 Thermal Cycler on a regular schedule to prevent reagents from accumulating and interfering with the ability of the block to change temperature quickly.

To clean the sample block, follow these instructions, paying careful attention to the warnings:

- **Clean the block wells.** Clean spills immediately to prevent them from drying inside wells. Use disposable plastic pipets with water (recommended), 95% ethanol, or a 1:100 dilution of bleach in water. Always rinse the wells with water several times to remove all traces of ethanol, bleach, or soap
- **If oil is used, the wells must be cleaned thoroughly and often.** Use of oil in the wells is not recommended. Clean the oil when it is discolored or contains dirt. Use a solution of 95% ethanol to clean oil. Do not allow oil to build up in the block

**WARNING!** If left in the block wells, bleach, ethanol, or soap could corrode the block and/or destroy tubes and microplates during a run. Always rinse the block well after cleaning it with any solution other than water.

**WARNING!** Never clean the block with strong alkaline solutions (strong soap, ammonia, or high-concentration bleach). Never use corrosive or abrasive cleaning solutions. These cleaning agents can damage the block and prevent precise thermal control.

**WARNING!** Never heat the block after adding a cleaning solution. Heating the block with cleaning solution damages the block, lid, and thermal cycler base.

**WARNING!** Never pour water or other solutions in the sample block. Wet components can cause electrical shock when the thermal cycler is plugged in.

## Testing and Fixing Insufficient Airflow

The T100 Thermal Cycler requires sufficient airflow to precisely heat and cool to the correct target temperature. If the flow of air is blocked, the thermal cycler cannot ramp to the correct temperature in the specified time. The airflow is sufficient when the thermal cycler heats and cools to the correct target temperatures promptly. When the T100 Thermal Cycler is first set up in a new location, use the following steps to determine whether there is sufficient airflow:

1. Set up the instrument in the location where it is going to be used, then turn the power on.
2. Adjust the local environment for typical conditions. Turn on any nearby equipment, such as fans. Also open any window blinds to reproduce typical conditions during a run. If more than one thermal cycler is in the area, run a protocol on all the thermal cyclers at the same time.
3. Run a typical PCR protocol for 30 min. To run a protocol, samples are not required; however, an empty microplate or tubes should be included. The lid does not heat correctly if it touches the hot block of the reaction module.
4. Measure the air temperature at the air intake vents of all the thermal cyclers.

If the air temperature near the thermal cycler is above 31°C, make one or more of the following changes to increase the flow of cooler air around the thermal cycler:

- Adjust air conditioning to lower the ambient air temperature
- Move the thermal cycler to another location
- Provide more space around the T100 Thermal Cycler and between adjacent instruments. Arrange instruments so that the warm exhaust air from one instrument does not enter the air intake vents of another
- Shield the thermal cycler from heat sources such as radiators, heat-producing instruments, and bright sunlight

## Replacing Fuses

Fuses on the T100 Thermal Cycler are designed to blow in case of severe power surges or other causes of electrical short. This process protects both the user and the instrument from excessive electric charge. Fuses on the T100 Thermal Cycler rarely need to be replaced. However, some institutions prefer to replace fuses on a regular basis to maintain uninterrupted operation.

If the thermal cycler does not turn on, first check that the power cord is plugged into a functioning power source. Also, check that the power cord and power source are within the specifications for this instrument. To replace a power cord, contact Bio-Rad Technical Support.

Finally, check that the fuses are intact. The T100 Thermal Cycler runs with two fuses (Figure 29). To remove and check the fuses, follow these steps:

**WARNING!** To prevent electrical shock, always turn off the instrument and unplug it from the electrical outlet before checking the fuses.

Use a small coin to unscrew the fuse drawer.



Fig. 29. The fuse drawer on the back of the T100 Thermal Cycler.

5. Pull out the fuse drawer and remove each fuse.
6. If a fuse is damaged, replace it with the correct fuse, and close the drawer. A bad fuse shows a break or burned spot in the metal. A good fuse has intact metal.

## Replacing the Battery

The battery needs to be replaced if the time and date do not remain set after the unit is turned off. The battery is a 3V lithium coin cell (Renata CR2477N, Bio-Rad catalog #9001228-SVC) and is mounted in the battery compartment on the bottom of the unit.

Contact your Bio-Rad Service Representative for assistance with battery replacement.



## Precautions and Instructions about Battery Replacement

**WARNING!** If misused or abused, the battery may explode or leak, causing injury to personnel and/or damage to the unit. Do not attempt to revive or recharge a used T100 battery by any means. Do not expose the battery to flames, high temperatures, moisture, or direct sunlight. Do not open, dismantle, modify, or short circuit the battery.

1. Disconnect the power cord.
2. Turn the unit over so the bottom faces up and remove the green access panel.
3. Note the orientation of the old battery in the battery holder.
4. Remove the old battery from the battery holder and place it on a nonconductive surface such as a sheet of paper.
5. Install the new battery into the battery holder with the same orientation noted earlier.
6. Replace the access panel and turn the unit right-side up.
7. Reconnect the power cord.
8. Prior to disposal, protect the old battery from shorts by sealing it in the packaging from the replacement battery or by wrapping it with insulating tape.
9. Dispose of the old battery in accordance with local rules and regulations.

### California, USA Use Only

Lithium battery in the equipment contains perchlorate.

Perchlorate material — special handling may apply.

See [dtsc.ca.gov/hazardouswaste/perchlorate](https://dtsc.ca.gov/hazardouswaste/perchlorate).

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