



WHITE PAPER

Temperature Module for Heating and Cooling

Accuracy, Uniformity and Time-to-Temperature

Written by
Opentrons



SECTION 1

Product Description

The Opentrons Temperature Module is a hot and cold plate module that is able to maintain steady state temperatures for use within the OT-2 liquid handler or as a standalone benchtop product. The Temperature Module can readily be used with the Opentrons App. Temperature capacity ranges from 4°C to 95°C.

The data in this paper illustrates the accuracy, uniformity and time-to-temperature of the module along with the 1.5 - 2mL and PCR thermal block accessories. All results were collected in real-world environments to better simulate conditions users are expected to experience in their own labs.



Temperature Module with 1.5 - 2mL Thermal Block



Temperature Module with Flat Plate Adapter



Temperature Module with PCR Thermal Block

SECTION 2

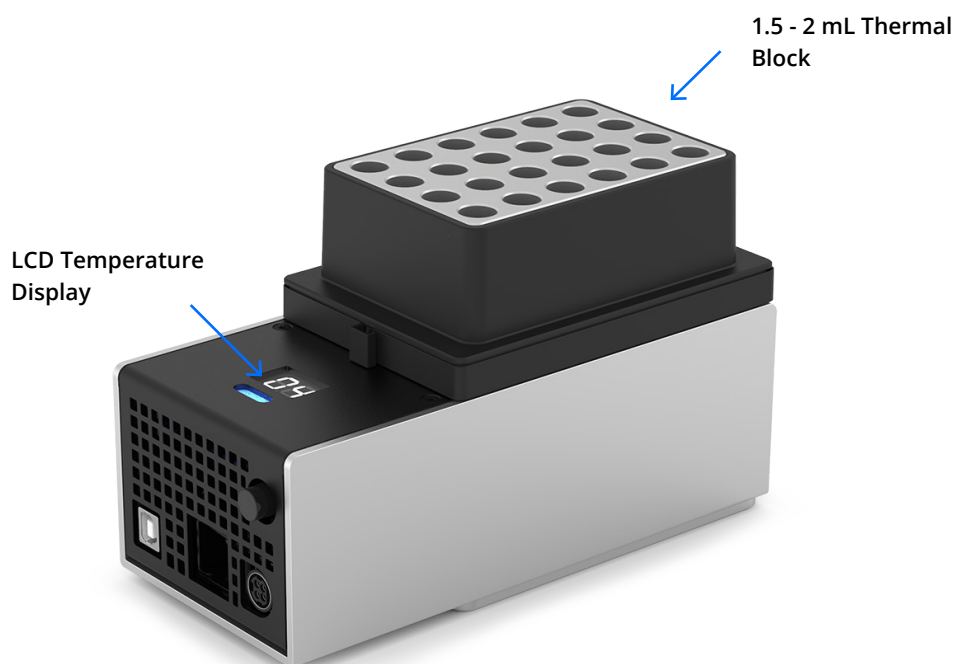
Temperature Module with 1.5 - 2 mL Thermal Block

Accuracy: maximum measured difference between the LCD temperature display and the average measured thermal block temperature.

Uniformity: +/- temperature variation measured across the thermal block wells.

Time-to-Temp: total time for both the top plate and thermal block to reach the desired steady state temperature starting from ambient conditions.

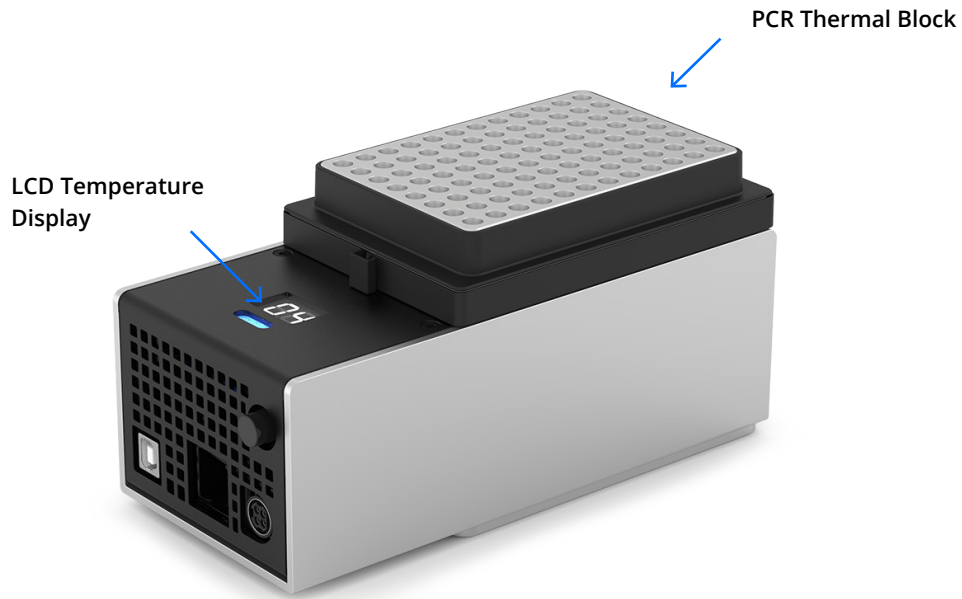
Environmental Test Conditions: data shown was collected at 22°C and 37% relative humidity. Different test conditions may provide for different results.



LCD DISPLAY TEMPERATURE (C)	TOP PLATE ACCURACY (C)	TOP PLATE UNIFORMITY (C)	TIME-TO-TEMP FROM AMBIENT (MINUTES)
4	± 1	± 0.3	18:00
37	± 1	± 0.15	3:00
65	± 1	± 0.3	6:00

SECTION 2

Temperature Module with PCR Thermal Block



LCD DISPLAY TEMPERATURE (C)	TOP PLATE ACCURACY (C)	TOP PLATE UNIFORMITY (C)	TIME-TO-TEMP FROM AMBIENT (MINUTES)
4	± 1	± 0.3	12:00
37	± 1	± 0.15	3:00
65	± 1	± 0.3	6:00

SECTION 3

Environmental Conditions and Condensation

It is recommended that laboratory conditions be < 22°C, < 60% relative humidity in order for the temperature module and its corresponding thermal blocks to reach the desired cold state temperatures near 4°C. Opentrons has not validated that the temperature module will function as desired within lab conditions of a higher temperature, humidity, or some combination of the two.

The operator may observe condensation on the module's cold surfaces upon reaching values below room temperature. The exact temperature at which condensation will occur depends on the lab atmospheric temperature and relative humidity conditions. This can be calculated from any standard "Dew Point Index" condensation table.

WATER BATH PLASTIC TUBES, STRIPS AND PLATES

It is highly recommended that users place water between aluminum thermal blocks and plastic well tubes, strips and/or plates. Water baths allow for the highest temperature uniformity, accuracy, and time-to-temperature for the liquid inside the wells. Air gaps, container sizes/brands, and pressure applied to the container can all significantly affect temperature results without use of a water bath. The following tables provide suggested thermal block water bath volumes for adequate coverage of each well size.

PCR THERMAL BLOCK	0.2 µL STRIP OR PLATE	0.3 µL STRIP OR PLATE
Water Bath Volume	110 µL	60 µL

1.5 - 2 mL THERMAL BLOCK	1.5 mL TUBE	2.0 mL TUBE
Water Bath Volume	1.5 mL	1 mL

TEST MEASUREMENT EQUIPMENT USED

Temperature Sensor: KS103J2 Thermistor

POWER USAGE

Module input: 36V, 6.1A (220W max)

Power adapter input: 100-240VAC, 50/60Hz

SECTION 4

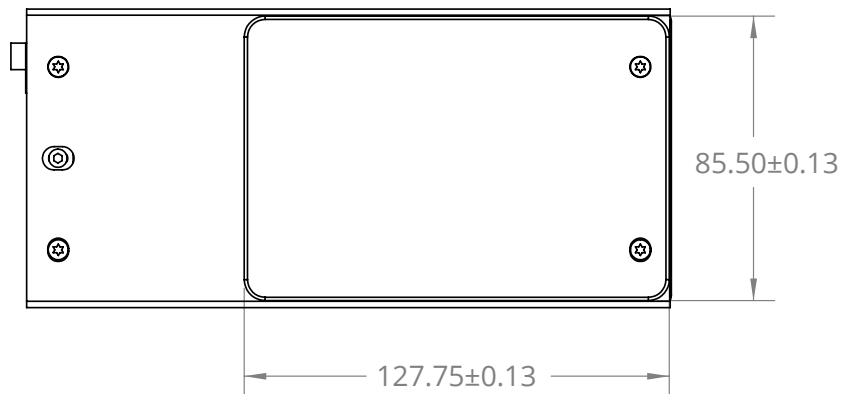
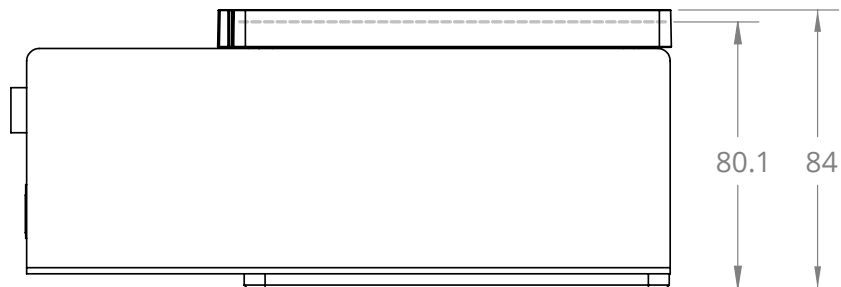
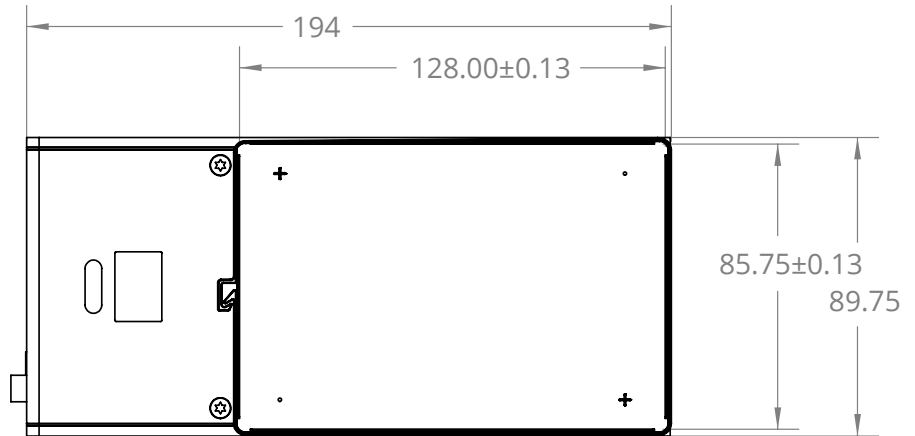
Dimensional Drawings

Millimeter units are shown in all dimensional drawings.

DIMENSIONAL DRAWINGS

Temperature Module

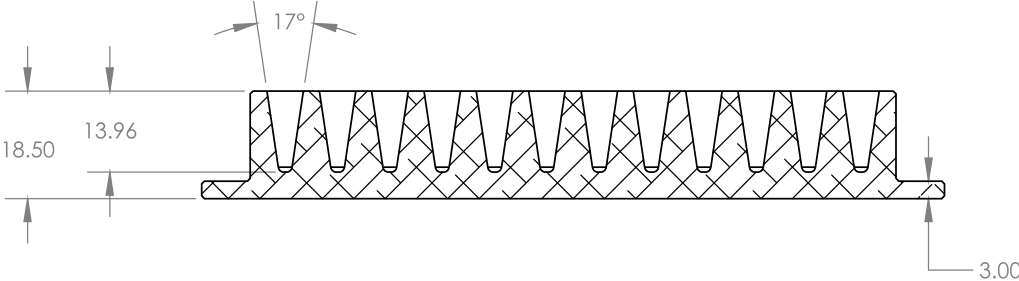
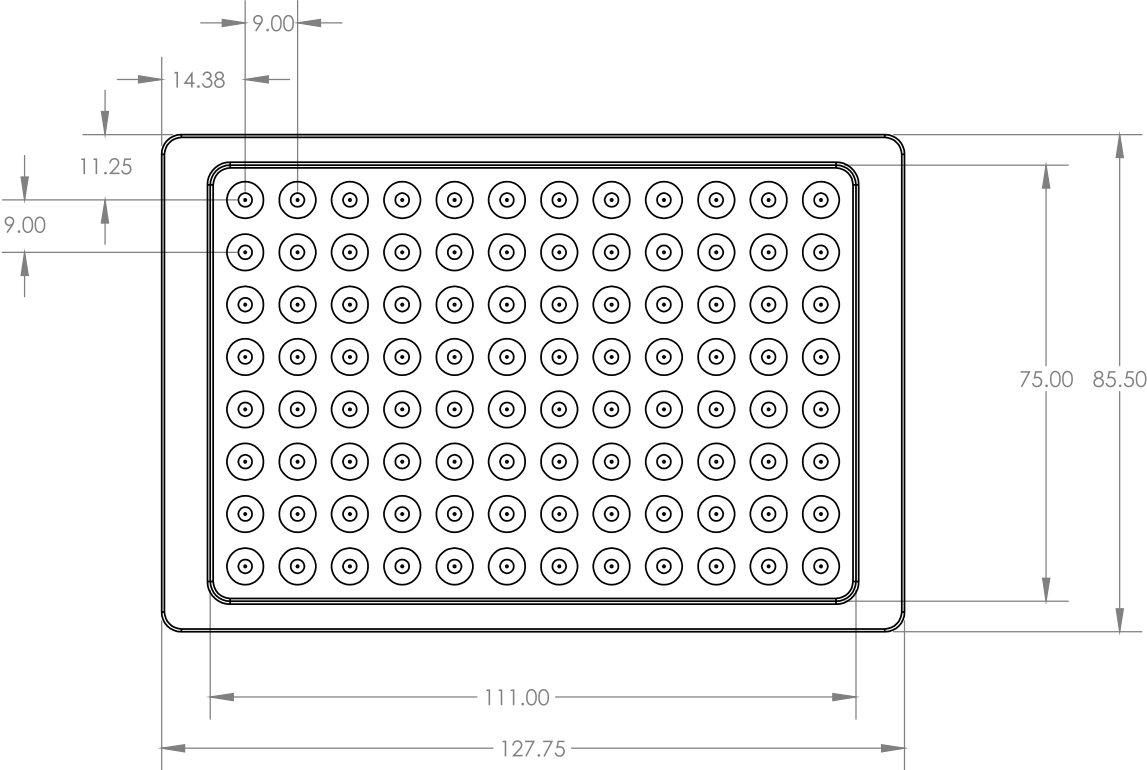
Mass: 1.5kg



DIMENSIONAL DRAWINGS

PCR Aluminum Thermal Block

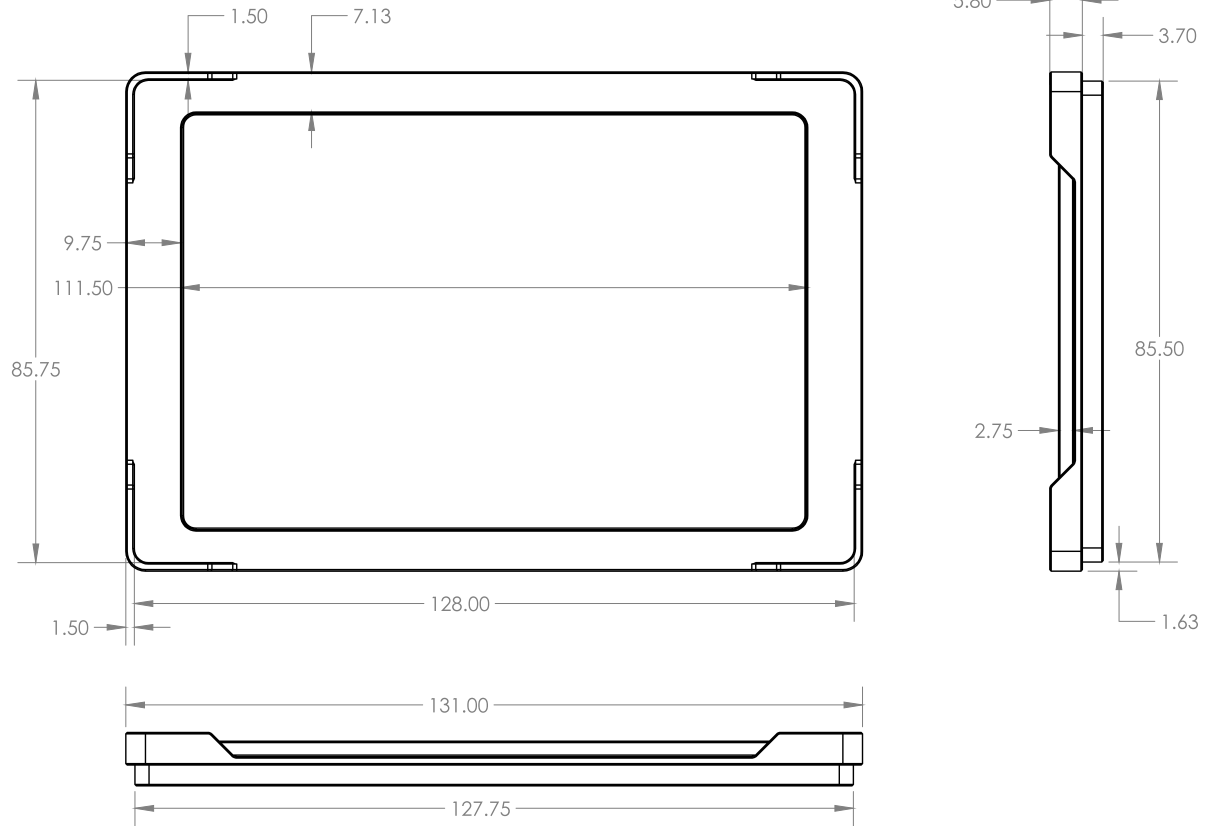
Mass: 0.4kg



DIMENSIONAL DRAWINGS

Flat Bottom Plate Thermal Block

Mass: 0.22kg



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